September 18, 1919 American Machinist Vol. 51, No. 12

Le Blond Multi-Cut Semi-Automatic Lathes

SPECIAL CORRESPONDENCE

Machines for specialized repetition work are seldom good for small lots, owing to setting-up and tooling difficulties. These machines have no cams or complicated mechanisms to confuse the operator or set-up man, and are so designed that small lots may be run out very economically. An especially valuable feature is the multiple use of simple lathe tools for more or less complicated jobs of facing or turning.

THE line of lathes illustrated in this article is a line built for a definite mission of a specialized character. These lathes are made by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, and are known as their "Multi-cut semi-automatic manufacturing lathes." While these machines are semi-automatic, they are essentially lathes in every respect, for they have lathe characteristics and use lathe tools of the simplest form. They fit into a lathe department without disturbing present standards of equipment or work schedule and they require no special type of operator. There is a sharp line of demarcation, however, between this and the ordinary lathe, in the high production capacity per unit of labor, floor space and investment. The lathes can be supplied with a variety of drives and equipment, adapting them to any industry having duplication of turning or facing work.

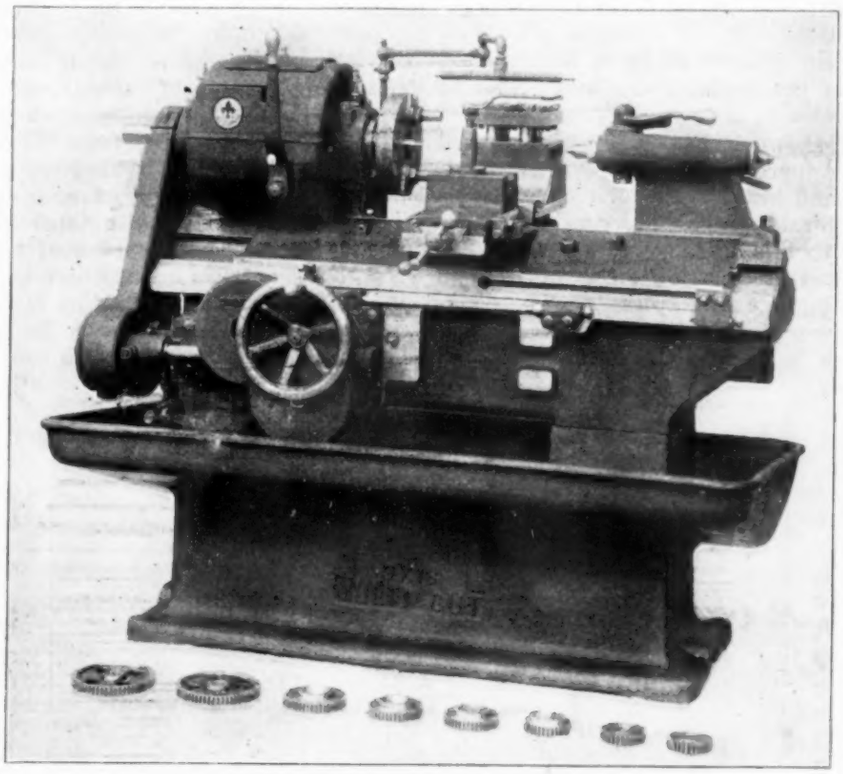


FIG. 1. NO. 9 MULTI-CUT LATHE WITH STYLE D HEADSTOCK

The work may be centered, held on mandrels or with expansion or closer chucks of either the pneumatic or the hand-operated type. On work that has been previously bored, reamed and rough-turned on the turret lathe or automatic, and remains to be finish-turned and faced, the Multi-cut lathe finds its legitimate field. Gear blanks, cone pulleys, bevel gears, pistons, steering knuckles, camshafts, transmission shafts, electric-starter details, etc., are rapidly turned and faced.

Much of the work that was formerly relegated to slower hand-operated machines may be successfully handled on Multi-cut lathes. By the nature of its construction, long, accurately scraped slides, extra large bearings, and its sturdy design, it is capable of cuts heretofore considered prohibitive on machines of this size. It isn't a lazy man's lathe, but the mental and physical effort to obtain a predetermined production result is reduced to an absolute minimum. The most efficient production is possible when one attendant is operating two machines. The automatic operation of the turning and facing slides and automatic trips at the end of their travel make this readily possible, the operator loading extra mandrels, while the cut is in progress. Turning and facing cuts are completed simultaneously, the slides finishing together. The varieties of combinations of time relation between the operation of turning and facing slides is unlimited. A simple system of change gears reading direct from the work diagram controls the relationship.

There are no cams to make or to consider; it is a simple combination of change gears and a taper guide bar. Due to the simple set-up and inexpensive forms of tools, smaller lots can be profitably run than on automatic machines requiring cam drums, etc., and lacking the flexibility of the Multi-cut lathe.

The lathes are built in two sizes: No. 6, 6-in. swing, 10-in. capacity between centers, and No. 9, 9-in. swing, 16-in. capacity between centers. The No. 6 Multi-cut lathe is built with three types of headstocks—styles A, C and D; the No. 9 with four types—styles A, B, C and D. Either size can be furnished with screw or quick lever acting tailstock, plain or universal angular facing attachment, taper attachment, compound rest, draw-in or closer chuck and collets.

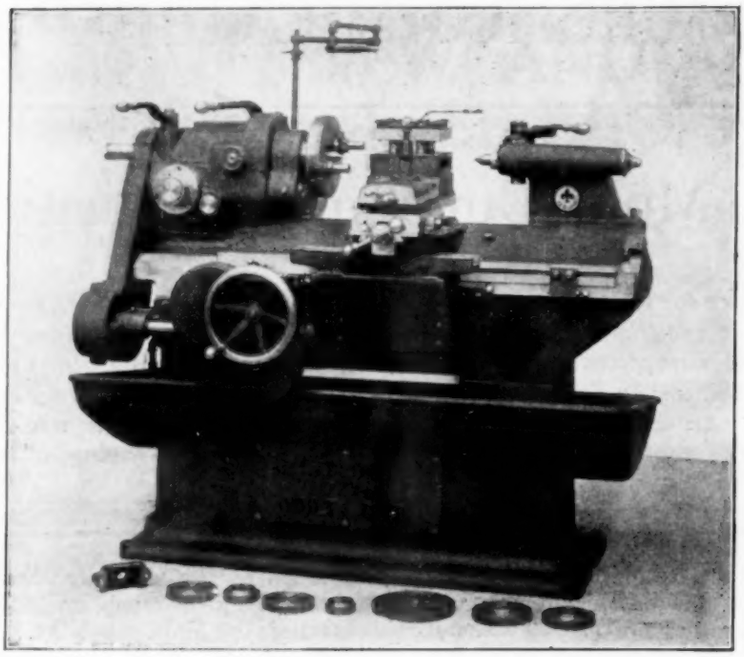


FIG. 2. NO. 9 MACHINE WITH STYLE B SELECTIVE-SPEED HEADSTOCK

Owing to the varied class of industries to which the Multi-cut lathe is adapted, this equipment is made selective, enabling the user to readily select the combinations best suited to his requirements.

Style D headstock, shown in Fig. 1, is a single-speed open-belt head, lever operated, and is provided with a friction start, stop and brake. The driving pulley is very large, and is accurately balanced permitting speeds to 1000 r.p.m., adapting this headstock to work on brass, bronze, aluminum, and free-cutting steels of medium diameters on which high cutting speeds may be maintained.

The friction clutch is mounted in the periphery of the driving pulley and is of the double-finger wedge-acting type, being adjustable for tension, and accurately balanced against all rotative forces. A brake is mounted on the spindle, bringing it to an instant stop when the clutch is released, a spring tension holding it into the brake preventing accidental starting.

The spindle bearings are bronze, babbitt lined and provided with sight-feed oilers. The thrust is absorbed against ball-thrust bearings. This head is intended to be driven from the lineshaft. A jack-shaft with split pulley can be supplied.

Style B headstock, shown in front and rear views, Figs. 2 and 3, is six speed, selective geared, right-angle driven. Three instantaneous changes are obtained with one lever, a shifter knob compounding these changes through a back gear for six speeds. The gears are of 3½-per cent. nickle-chrome-steel heat-treated and hardened. The headstock is oil-tight, the gears and friction clutches running in a continual bath of oil. The spindle bearings and driving clutch are also continuously flooded with oil from this same supply. The main friction clutch is mounted in the driving pulley, where it is operating at a constant high rate of speed and subject to little strain. It is of the multiple-disk type, running in oil, with a brake operating from the clutch handle. The driving pulley shaft is at 90 deg. to the spindle to permit of a more compact grouping of the machine. The spindle is fitted with taper bronze boxes, babbit lined with convenient means of adjustment for wear. The thrust is taken against high-grade ball-thrust bearings. This head is supplied on No. 9 machines only.

Style A headstock, shown in Fig. 4, is a single speed, plain back geared, with self-oiling, bronze bushings, ball-thrust bearing spindle, and double helical or herringbone back gears. The spindle bearings are renewable bronze boxes, babbitt lined. The main driving pulley is exceptionally large in diameter and of wide face, productive of greater driving power than heretofore utilized on lathes of this size. A friction countershaft with an automatically operating brake is supplied as regular equipment.

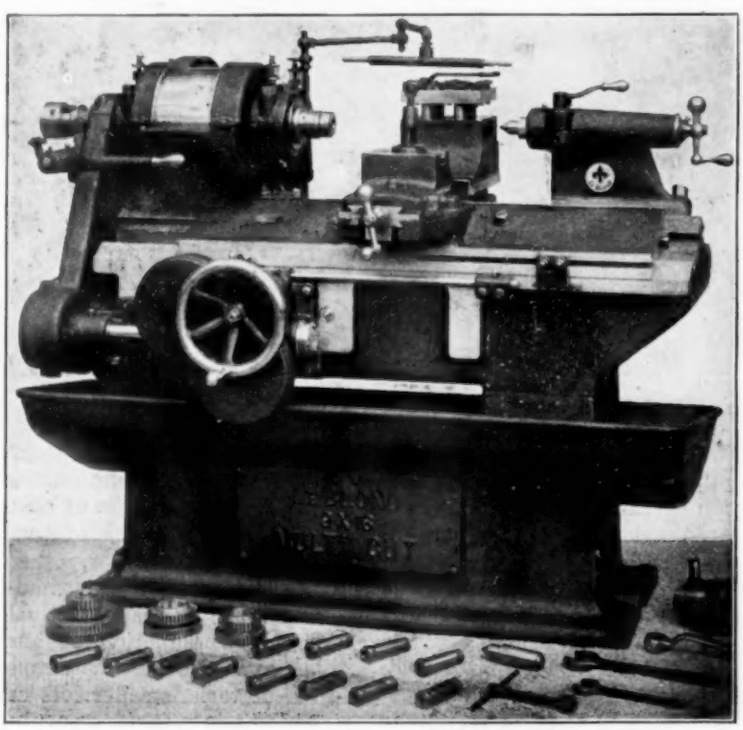


FIG. 4. NO. 9 MACHINE WITH STYLE A HEADSTOCK

This style of headstock is best adapted to the class of work requiring one or more speed changes for roughing or finishing of varying diameters of work. Where the machines

are installed in batteries and one or more jobs may be assigned to any machine, it is driven direct from the lineshaft. Where this is not feasible a jackshaft can be furnished at an additional price.

Style C headstock, shown in Fig. 5, is a fixed-speed set-up head, for quantity duplicate production. The speed may be adjusted to suit conditions by means of change gears regularly furnished to provide three changes. A four-to-one back gear is incorporated in the drive, the changes being made by simple slip gears in the end of the head. The driving clutch, brake, spindle bearings, etc., are identical with the style B head. The same system of flooded lubrication for gears, bearings and clutch are also employed. The head is provided with a right-angle drive and is intended to be driven direct from the lineshaft. When this is not feasible a jackshaft can be supplied at an extra cost.

This headstock is best adapted to work on cast-iron or steel parts, requiring fairly heavy reductions and no speed changes, for duplication work in quantities and where the machines are placed in parallel lines in regular lathe departments and driven from a countershaft. The countershaft is provided with split pulley to facilitate speed changes when required.

A head-end view of one of these lathes is given in Fig. 6, and a tail-end view in Fig. 7. The latter illustration shows the taper attachment, right-angle drive and equalizing faceplate. It also shows the special anvil-type bed and the extra long carriage bearing that passes either the head or the tailstock.

A lathe with style C headstock is shown in Fig. 8 machining an automobile hub, using nine tools at once. Two of these hubs after machining are shown in Fig. 9. In Fig. 10 several tooling set-ups are shown for typical shop jobs.

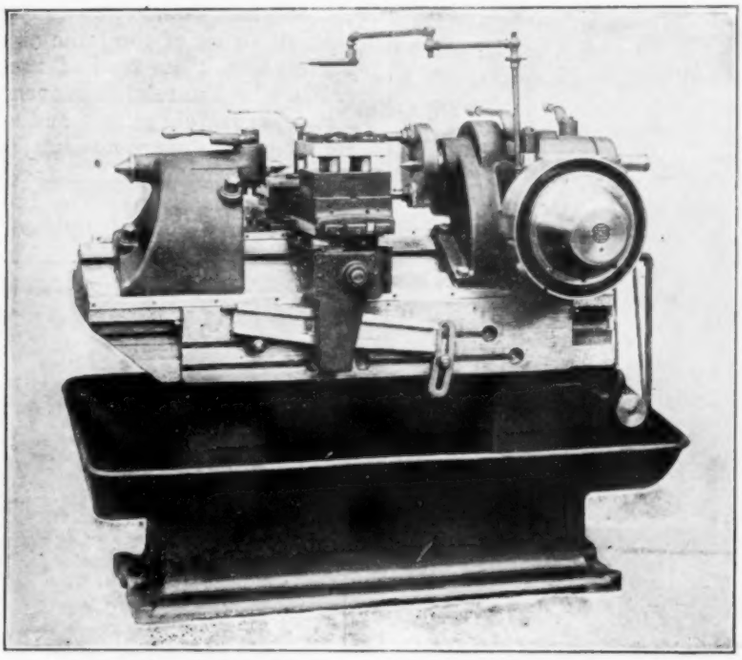


FIG. 3. REAR VIEW OF LATHE SHOWN IN FIG. 2

The bed is of a special anvil section, as just mentioned, with broad slides for the carriage and bearings for the head and tailstock, so disposed that the pressures resulting from the cut tend to force the slides more firmly to a bearing. The slides are much broader than usual and are provided with narrow dovetail guiding shears, which are taper gibbed and prevent any tendency to lift from the bearing.

The bed is strongly ribbed internally and mounted on a cabinet base, in which the pan and chamber for cutting compound is cast. The pan becomes an integral part of the bed and greatly stiffens the entire machine. The pan is provided with a strainer that separates the chips from the cutting compound, which flows back to the base of the machine. A geared rotary pump and piping for circulating the compound is supplied as regular equipment. A cover plate is provided for cleaning out the base.

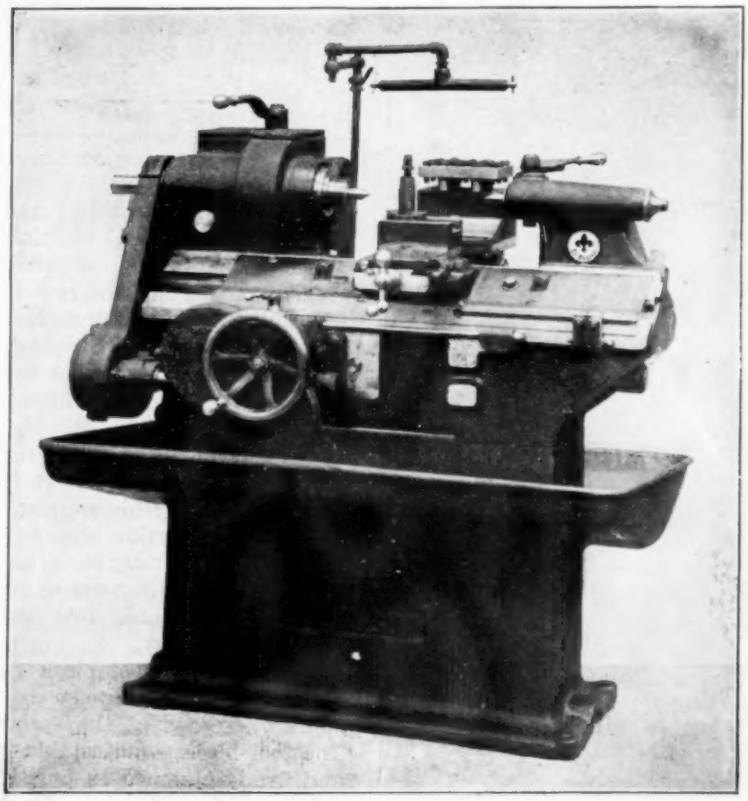


FIG. 5. NO. 6 MACHINE WITH STYLE C, ADJUSTABLE-SPEED GEARED HEADSTOCK

The carriage has a broad slide extending practically the full length of the bed and scraped to a bearing. It is provided with double taper gibs with fine thread adjustment. The cross-slide for mounting the compound or plain rest is massive and cast integral with the carriage. The fact that the head and tailstock are located and carried by the rear shear permits the carriage to travel past them and keep the slides continuously covered. The extremely long carriage bearing is one of the largest contributing factors to the general rigidity of these lathes, permitting the use of gang tools, forming slides, etc., without the

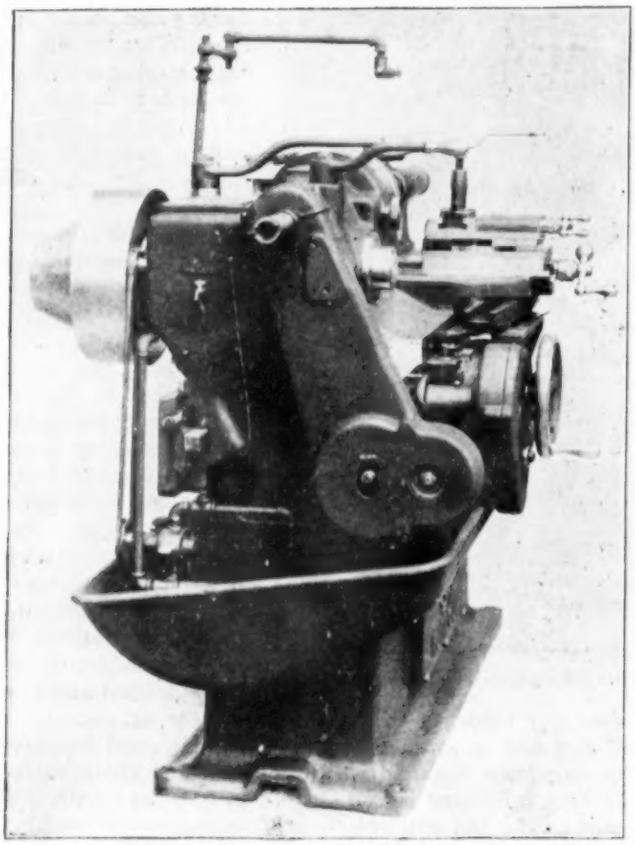


FIG. 6 HEAD-END VIEW OF MACHINE

usual tendency of the carriage climbing and binding on the shears. The feed rack is set in the center of the carriage slide, giving a smooth feed.

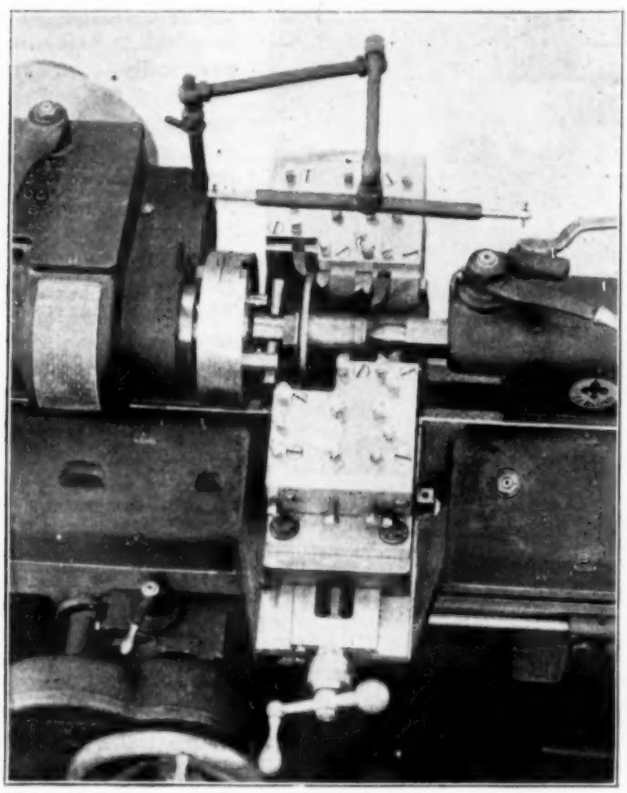


FIG. 8. LATHE SET-UP FOR MACHINING AUTOMOBILE HUB

The plain facing attachment faces diameters up to the full swing of the lathe at right angles to the turning centers. The feed of the facing slide is obtained entirely by the relative movements of flat and dovetail, slides accurately gibbed and adjustable, to compensate for wear. There are no cams, either fixed or adjustable, to make or consider. The facing rest is fed toward the center of the lathe on a broad square lock slide to which it is accurately gibbed. The cross-facing slide

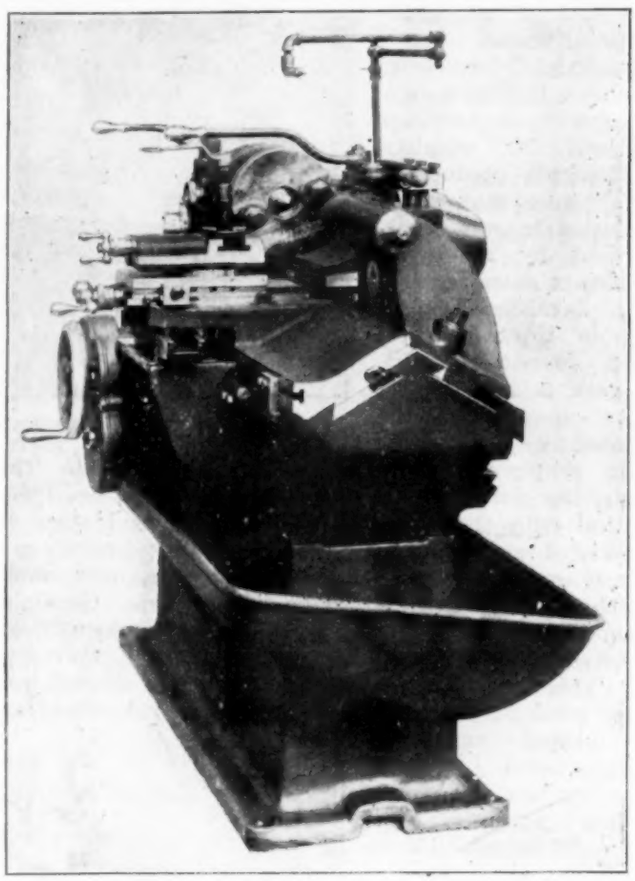


FIG. 7. TAIL-END VIEW OF MACHINE

is movable along the bed and rigidly clamped to the shears in any desired position.

The facing-bar slide carries the swivel guide bar which is fed along the bed at varying rates of speed.

A sliding shoe on the facing attachment slide engages the swivel guide bar which may be set at any angle within the range, imparting a vertical motion to the shoe which is transmitted through a rack and hardened pinion to the cross-slide. By changing the angularity of the swivel guide bar the feed of the cross-slide is varied or timed to complete its work at the same time as the turning slide or may be accelerated to finish ahead of the turning slide to permit of overlapping on forming and turning tools, or vice versa.

The feed to both turning and facing slide are tripped by the same clutch and will duplicate within close limits of accuracy.

The standard tool block furnished is arranged for multiple tools which can be held parallel or at any angle by reason of the spacing of the binder screws. The tool block is adjustable to the center of the lathe and firmly clamped in position by two heavy bolts.

The universal facing attachment, as its name indicates, is adapted to angular facing operations on bevel

gears, etc. When used in connection with a taper-turning attachment, the back and face angles can be turned simultaneously.

The swivel block is accurately graduated to facilitate angular settings and clamped firmly in the selected position by two heavy T-slot bolts in a circular T-slot. The feed is through a pair of hardened generated miter bar, resulting in a practically unlimited combination of feed relations. When on forming or heavy reductions with the facing slide, it is sometimes desirable to accelerate or decelerate the feed as it approaches the center; it is done by replacing the swivel guide bar with a former bar and roller designed to suit a specific job.

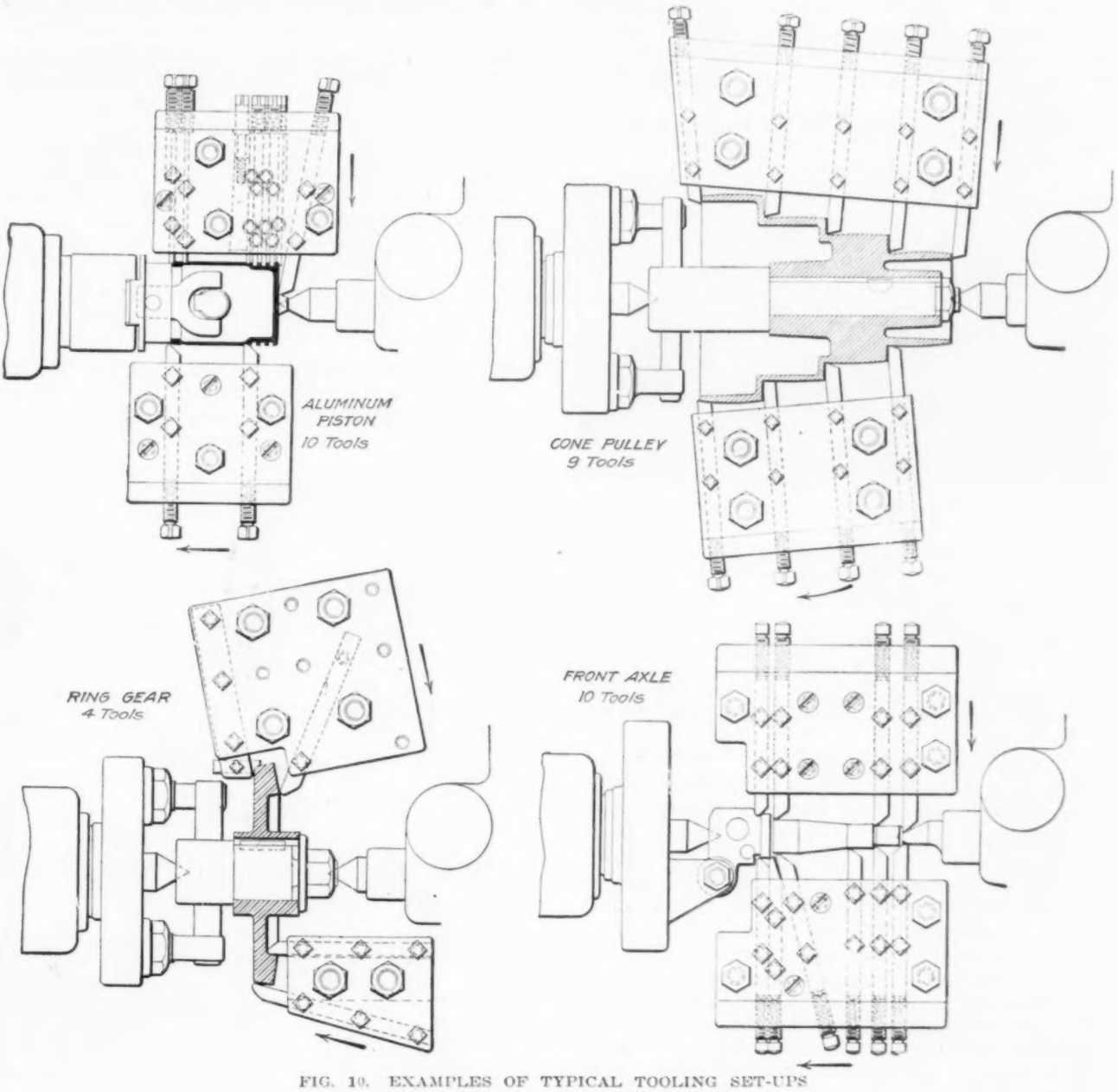


FIG. 10. EXAMPLES OF TYPICAL TOOLING SET-UPS

gears to the feed rack. Aside from this swivel feature, the Universal attachment and tool blocks are identical with the plain attachment.

The variations in feed for turning and facing slides are obtained by loose change gears applied to the feed bracket and worm box. The feeds read in "thousandths per revolution of spindle," and a simple, direct reading work diagram is sent with each machine to show the change-gear combinations and the resulting feeds.

The feeds of the front slide are fixed by the change gears used, while the feeds of the facing slide may be further varied with relation to the feed of the turning slide by the angularity given the swivel guide

The feed worm and wheel are on fixed centers and incased in an oil-tight gear box rigidly bolted to the bed. The feeds are tripped to a line by a sensitive-acting positive jaw clutch, heat-treated and hardened, engaging a similar clutch mounted on the wormwheel. The feed drive is through changeable gears and a pinion and bull wheel to the rack on the carriage. The drive to the facing slide is through similar change gears through the bed to the feed rack on the facing attachment slide on which the swivel guide bar is mounted.

The feed rack for both carriage and facing attachment is placed in the center of the slides imparting a

smooth, unrestricted feed without the usual binding action occasioned by applying the power away from the center of the guiding shears and the resultant great working strains.

A handwheel at the front of the worm box furnishes means of quickly returning the turning and facing slides to the starting position after the completion of each cut. The wormwheel and clutch run continuously in oil and the thrust of the worm is taken against ball-thrust bearings. All of the gears subject to the greatest strains are of nickel steel, heat-treated and hardened.

A plain block rest mounted on the cross-slide is regularly furnished, equipped with a single-screw toolpost

FIG. 9. HUBS TURNED AND FACED IN THE MACHINE

and an adjustable positive cross-stop. A substantial compound rest can be supplied when conditions require it. The swivel is large in diameter and graduated in degrees for angular turning or taper boring. Adjustable taper gibs are provided to compensate for wear on the slides. The T-slot bolts are large in diameter and are placed in a circular T-slot enabling the top and swivel slides to be firmly clamped after setting.

Lever-Operated Quick-Acting Tailstock

A quick lever acting tailstock is provided to permit of the quick removal and replacing of work with a single movement of the operating handle. The center is brought into contact with the work at any desired pressure, by a conveniently placed lever, further movement of the same lever rigidly locking the tailstock barrel and clamping the spindle.

The taper-turning attachment consists of a rigid bracket bolted to the front of the bed, which carries an adjustable taper guide bar and a sliding shoe engaging the guide bar. The sliding shoe is attached to the cross-slide imparting to it an "in" or "out" movement with relation to the angular setting of the guide bar. The guide bar may be set from straight to 4½-in. taper per foot, either side of center, and clamped in the selected position by two heavy T-slot bolts. The taper guide bar and sliding shoe may be replaced by a form plate and roller for the automatic duplication of irregular shapes.

Style B or C headstocks may be motor driven. The motor is attached to a motor plate hinged from the cabinet base of the machine and provided with an adjustable jack for maintaining the desired belt tension.

A constant-speed motor, alternating- or direct-current, running preferably at 1200 r.p.m. is recommended, 3 hp. for the No. 6 lathe and 5 hp. for the No. 9. A cast-iron belt guard is supplied for completely inclosing the belt and pulleys.

Air Chucks and Draw-in Attachments

The spindles on all Multi-cut lathes are regularly extended for the application of air chucks, special expansion mandrels, closer chucks, etc.

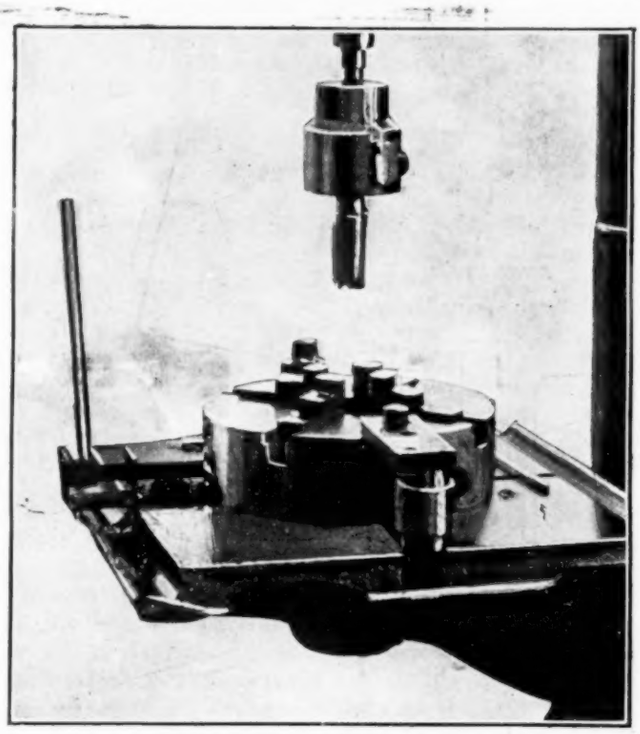
A lever operating a draw-in attachment, closer and full set of collets is supplied when required. These collets are made in sets and furnished as follows: No 6 Multi-cut, 11 collets, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{7}{16}$, $\frac{1}{2}$, $\frac{9}{16}$, $\frac{5}{8}$, $\frac{11}{16}$, $\frac{3}{4}$, $\frac{13}{16}$, $\frac{7}{8}$, in. capacity; No. 9 Multi-cut, 13 collets, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{7}{16}$, $\frac{1}{2}$, $\frac{9}{16}$, $\frac{5}{8}$, $\frac{11}{16}$, $\frac{3}{4}$, $\frac{13}{16}$, $\frac{7}{8}$, $\frac{15}{16}$, 1 in. capacity.

The company maintains an engineering service for the layout and recommendation of tool equipment for these lathes, and they will design and build special tools for a guaranteed output.

Chuck Wrench Retainer

By W. H. Addis

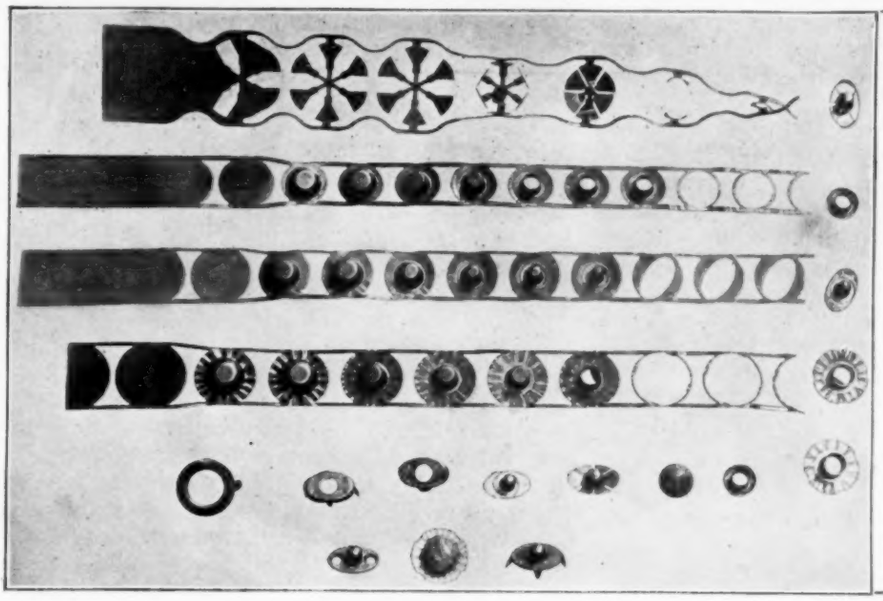
There are many practical ways in which the "universal" type of lathe chuck may be used for chucking duplicate parts that are to be machined on the drill press. The illustration shows a four-jaw chuck, with the



CHUCK WRENCH RETAINER

adapter plate removed, firmly clamped on the drilling-machine table.

In setting up this job a little extra effort was put forth to save the usual trouble which the loose "T" handle chuck wrench causes the operator. The wrench is held by a simple strap-iron housing bolted to the table. The long handle on the wrench gives sufficient leverage for the operator to chuck and release the work with his left hand, leaving the right free to operate the feed lever. It is the little refinements that make profitable production.



Dies for Snap Fasteners

Special Correspondence

This is a study in continuous punching, and shows, almost without words, how complicated pieces can be punched and formed. It cannot fail to assist anyone interested in the design of punches and dies.

THE four sets of self-pressed punches and dies illustrated herewith are for making fasteners of various kinds, samples of the work being illustrated in the headpiece. None of these requires extended description, as the strip between the punch and die, together with the reference letters on each, shows the sequence of the operation in each case and makes it clear to any die designer or maker as to just how the operations proceeded.

In making the eyelet in Fig. 1 the hour-glass-shaped opening gives nearly a complete circle after the first stroke, the various drawing punches draw up the cup, finally pierce the top and complete the eyelet as shown.

A slightly different piece is shown in Fig. 2, although

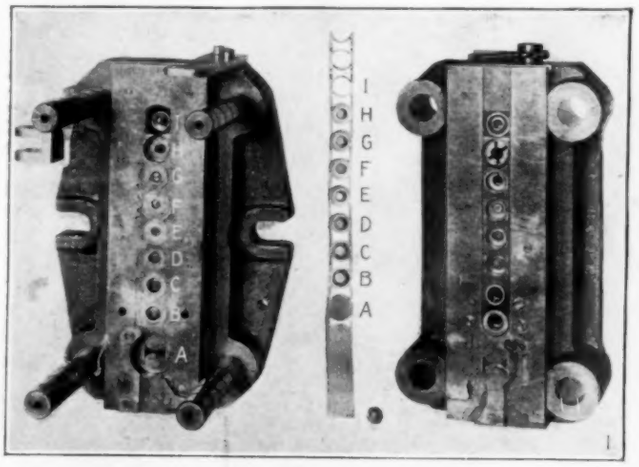


FIG. 1. DIES FOR ROUND EYELETS

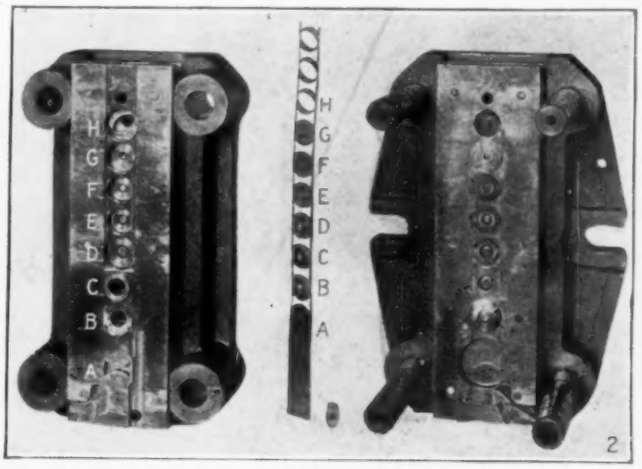


FIG. 2. DIES FOR OVAL FASTENER

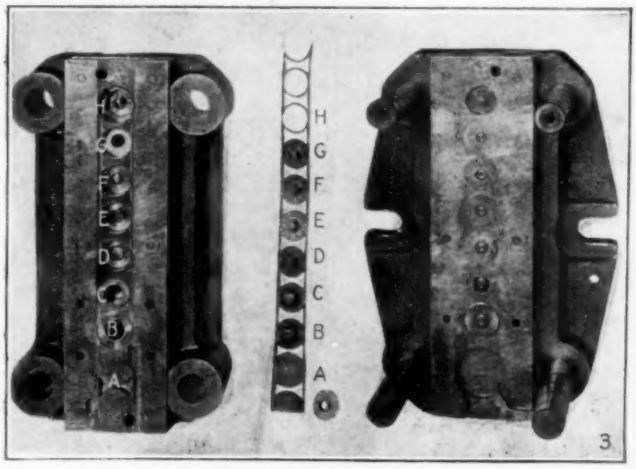


FIG. 3. PUNCHING AND FORMING DIES

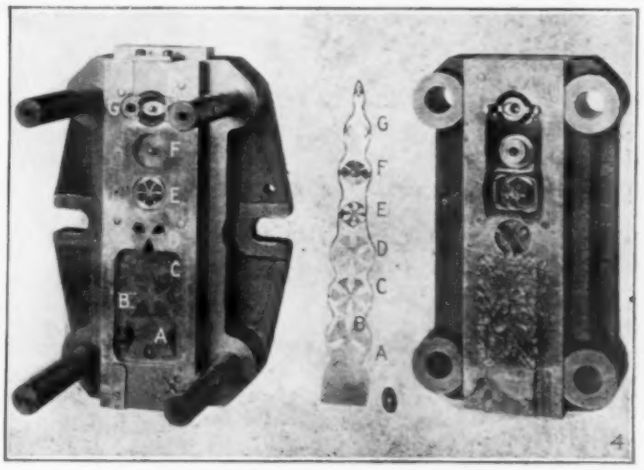


FIG. 4. CUTTING AND FORMING A SPRING FASTENER

the operations are identical, with the exception of omitting the punch, as this piece retains a solid top. The reference letters in each case show the sequence of operations very clearly.

Another very similar piece is shown in Fig. 3, but Fig. 4 is quite different and much more complicated. Here the hour-glass-shaped punch is replaced by two curved punches, one on each side, shown at *A*. The succeeding operations are interesting and worthy of careful study by diemakers. It will be noticed that *E* is a bending operation which entirely changes the appearance of the standing, while *F* restores it to more of its original appearance, but in the meantime has formed the spring top which holds the eyelet in place. Altogether this is an extremely interesting piece of work. These dies were made by the Erb Manufacturing Co., Jersey City, N. J.

The Cleveland Trust Co. Educative Exhibits

EDITORIAL CORRESPONDENCE

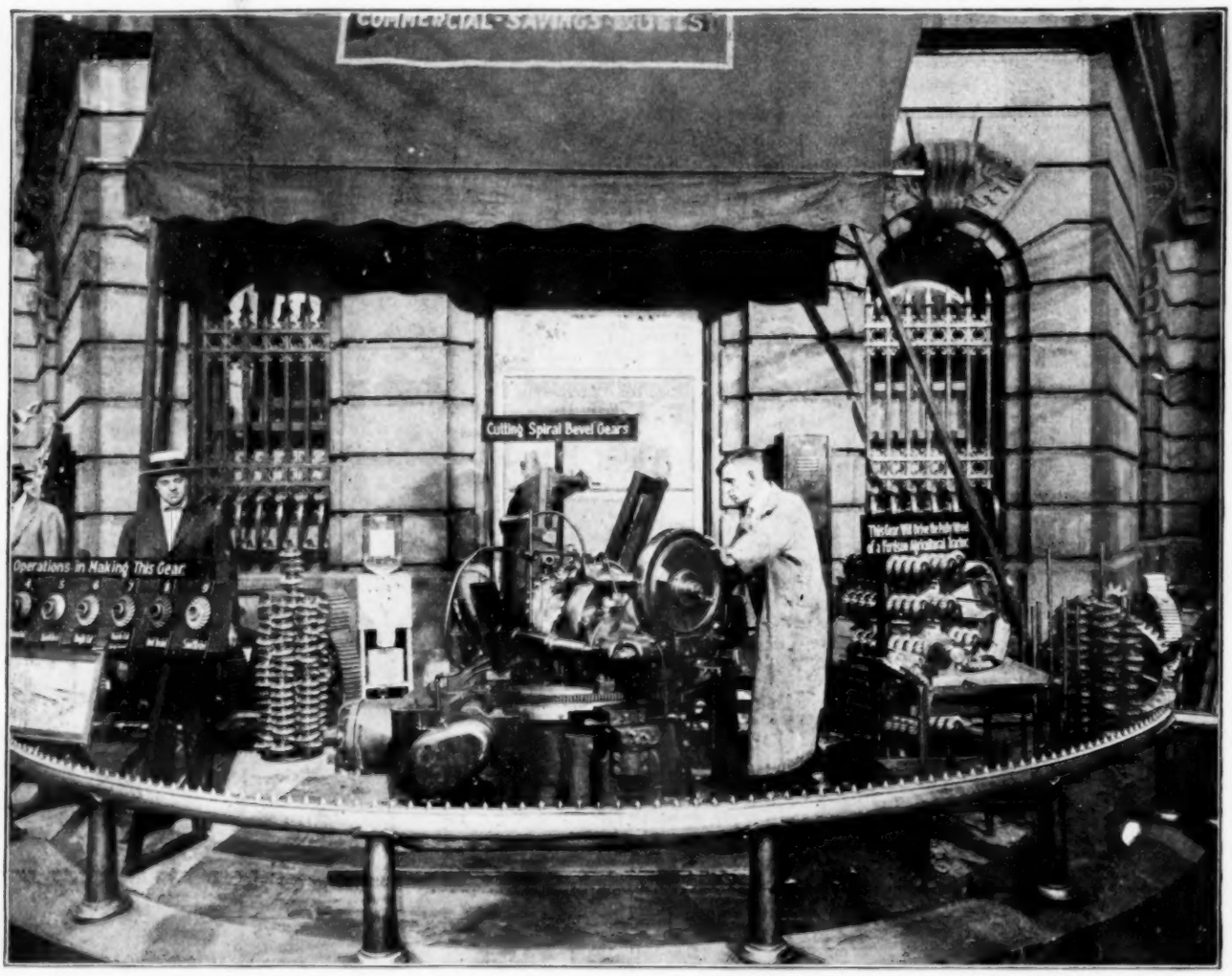
A novel, pleasing and instructive exhibit was staged on the busy corner of East 9th St. and Euclid Ave., Cleveland, Ohio, during the weeks of July 14 and 21.

It was a part of the series of educational exhibits conducted by the Cleveland Trust Co. in coöperation with prominent manufacturers and business men, for the purpose of bringing forcibly to the attention of the populace and visitors of Cleveland, the variety and scope of the city's industrial resources.

Upon a space belonging to the Trust company at the above-mentioned corner was mounted a Gleason spiral-bevel-gear generating machine with all its accessories—power unit, operator, etc.—and during the two weeks this machine was kept busily engaged in turning out gears of various kinds within the limits of its capacity at production speed and upon a regular production basis. The gears produced were being applied as fast as made upon an actual order, and thus the exhibit took its place as a part of regular production schedule.

The details of the exhibit were supplied by the Van Dorn & Dutton Co. of Cleveland, a part of whose regular shop equipment it was, as was also the extensive panel boards showing various transmission, differential and timing gears for automobile and tractor use; also miscellaneous spurs, bevels, spirals, worms and worm-wheels, racks and sprockets; motor gears and pinions for street cars; gears for electric cranes, hoists, and steam shovels; mill gears; mammoth gears for heavy-duty machinery; Bakelite, Micarta. and rawhide—in fact gears of all types.

Large crowds viewed the exhibit and technical men from all industries were attracted by the demonstration and much interest was shown by all who saw it.



STREET GEAR-CUTTING EXHIBIT AT CLEVELAND

Production Advertisement Filing System

By W. N. ALLEN, JR.

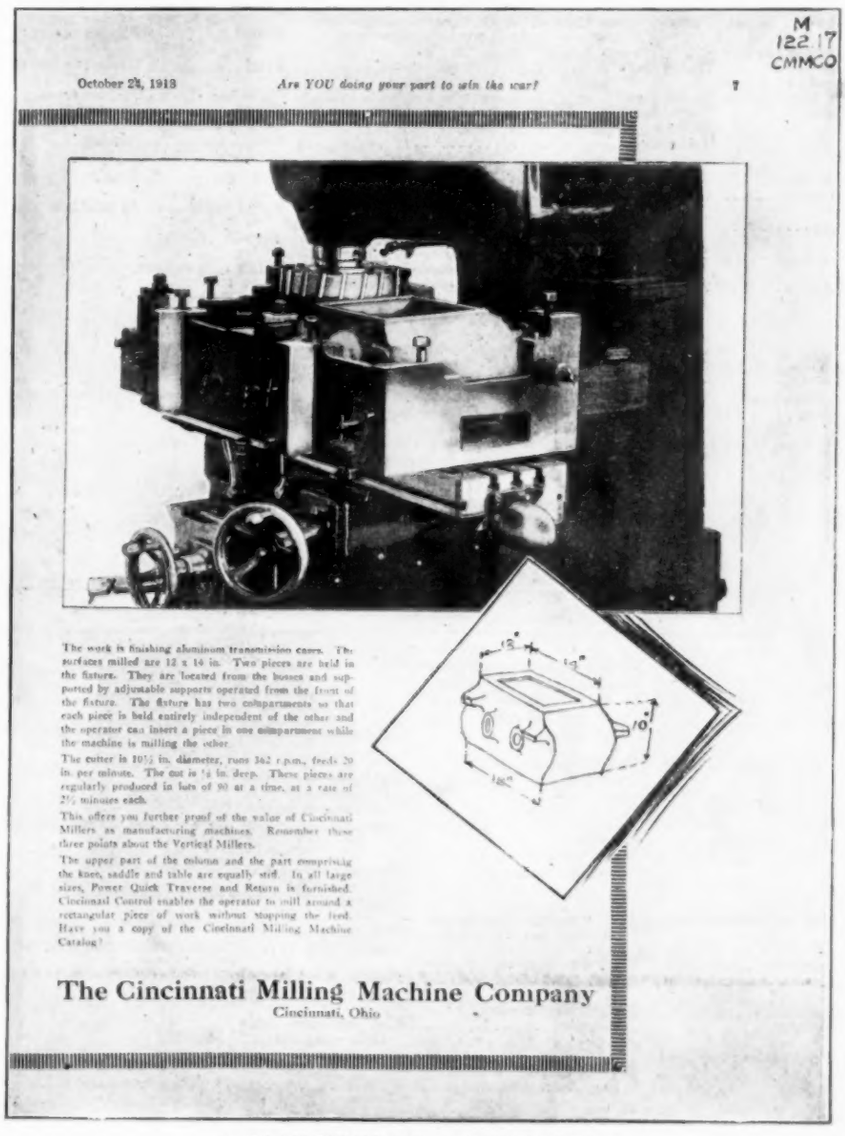
This article suggests a scheme for making the value of the advertising pages of technical periodicals more than merely transitory. Full details are given for a filing system which might also be applied to the "American Machinist's" Condensed Clipping Index with good results.

THERE was a time when all advertising was unseasoned. Salt had to be used in anything but homeopathic doses. Happily that day is over and it is now a cardinal principle of advertisers to tell the truth in whatever they say, even though they do not always say all that might be said.

Advertisements showing production figures and methods of machine-shop operations are of great potential value to apprentices, to demonstrators and machine set-up men, to tool designers, to those recommending purchases of machine tools, and in the highest degree to planning-department men for routing, estimating, time studying and rate setting.

But unless a person is able to compare the job advertised with something in his own experience, a full-page advertisement showing the production of so many pieces per 9½-hr. day on such and such a machine is liable to pass in one eye and out the other. Most men, interested at present in grinding, will study advertisements on that operation and not even glance at those on gear cutting nor remember them if they do. Two weeks from today, those same men may unexpectedly wish they could "find that advertisement they saw on gear cutting."

In order to have on hand when needed, comparative data on choice of machine, make of machine, methods of doing work, set-ups, tooling, cutting speeds, feeds, depths of cuts, etc., the writer, for the past two years, has cut out all advertisements with sufficient data to be useful and has filed them according to the class of machine to which they belong. As this data accumulated it became evident that a better method of classifying and indexing would have to be used. Since it is often a question as to what type or class of machine to use for a certain operation as for instance, keyseating, which may be done on keyseating, keyways, broaching, milling, planing, slotting and shaping machines and drill presses, it was decided to make the operation class the first index. This automatically throws together operations of the same class, regardless of the machine used (except when in combination), thereby giving a direct comparison of different types of machines on the same job.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CMMCO

October 2d, 1918 *Are YOU doing your part to win the war?* 7

The work is finishing aluminum transmission cases. The surfaces milled are 12 x 16 in. Two pieces are held in the fixture. They are located from the bosses and supported by adjustable supports operated from the front of the fixture. The fixture has two compartments so that each piece is held entirely independent of the other and the operator can insert a piece in one compartment while the machine is milling the other.

The cutter is 10½ in. diameter, runs 362 r.p.m., feeds 20 in. per minute. The cut is ¼ in. deep. These pieces are regularly produced in lots of 90 at a time, at a rate of 2½ minutes each.

This offers you further proof of the value of Cincinnati Millers as manufacturing machines. Remember these three points about the Vertical Millers.

The upper part of the column and the part comprising the knee, saddle and table are equally stiff. In all large sizes, Power Quick Traverse and Return is furnished. Cincinnati Control enables the operator to mill around a rectangular piece of work without stopping the feed. Have you a copy of the Cincinnati Milling Machine Catalog?

The Cincinnati Milling Machine Company
Cincinnati, Ohio

A PAGE FROM THE AUTHOR'S FILE

Mneomonic Symbols Used

A classification patterned after the Dewey system was used. All of the important operations occurring in machine-shop practice, including forging and welding, were given mnemonic symbols and arranged alphabetically. (See Table I.) A filing pocket 15 x 9½ x 1¾ in. (expanded) of a special tough fiber was purchased for each operation class. Each operation class was then subdivided into five divisions, three before the decimal point and two after. (See Table II.) Each of these divisions is capable of being divided into 10 sections from 0 to 9 inclusive. (See "Operating Classifications.")

In all cases the zero is used to designate data of too general a nature to be filed under the other sections or is used when information is lacking. The initials of the manufacturer form the final index. This gives an easily remembered symbol, especially in the

case of companies using their initials as a trade name or mark as in the case of NATCO, L & S, B & S, P & W, etc.

Table III shows the sections of the "Material" division. This classification is applicable to all operation classes and therefore is not repeated. Each "Operation Classification" sheet should be kept in its filing pocket. It will be found handy to have a duplicate set bound in one volume together with Tables I, II and III.

The halftone shows an example worked out. It will be seen that: M represents the operation class of milling; 100.00 represents a single flat surface, the class of work; 20.00 represents a vertical milling machine, the class of machine; 2.00 represents 2 fixtures, reciprocal, the method; 0.10 represents aluminum, the material; 0.07 represents 14 in. (12 to 20), the size; CMMCO represents the Cincinnati Milling Machine Co., the manufacturer.

In order to utilize actual values, the diametral pitch for "Gear Cutting" and the diameter and threads per

TABLE IV—A. COMPLETE CLASSIFICATION OF MACHINE OPERATIONS

SYMBOL Class of Work	B Broaching (Exclusive of Keyways)	BM Boring Mill	D Drilling Machine Operations	F Forging	G Grinding	GC Gear Cutting
100	Rectangular slots	Centering	Drill	Breaking-down	Cylindrical	Bevel
200	Miscellaneous shaped slots	Drilling (combined only)	Bore	Squeezing	Internal	Internal
300	Rectangular holes	Boring	Counterbore	Upsetting	Surface	Racks
400	Circular holes	Counterboring	Face	Heading	Disk	Spiral and herringbone
500	Miscellaneous shaped holes	Reaming (combined only)	Ream	Forming	Floor	Sprockets
600	Taper Holes	Facing	Tap (Combined only)	Drawing	Cylinder	Spun
700	Helical grooves	Turning	Countersink	Bending	Form	Worms
800		Thread cutting	Mill (combined only)	Punching	Crankshaft and camshaft	Wormwheels
900		Chamfering and cut-off	Thread (combined only)	Trimming	Rolls	Ratchets
Class of Machine						
10	Draw-cut—horizontal	1 Cross-rail head	Sensitive—single spindle	Power hammers—helve and spring (trip)	Cylindrical	Gear cutting
20	Push-cut—horizontal	2 Crossrail heads	Sensitive—gang spindle	Drop hammers—friction board	Internal	Hobbing
30	Draw-cut—vertical	1 Turret head	Upright—single spindle	Drop hammers—steam and pneumatic	Surface	Milling
40	Push-cut—vertical(arbor press)	2 Turret heads	Upright—gang spindle	Pressres—hydraulic and steam-hydraulic	Disk	Planers (gear)
50	Duplex	1 Crossrail head and 1 turret head	Heavy duty	Presses—crank	Floor	Rounding (gear)
60		1 Turret head and 1 side head (vert. turret lathe)	Radial	Forging machines	Cylinder	Shapers (gear)
70		Mult-au-matic	Turret head	Heading achines	Crank	Broaching
80			Multipl spindle	Bulldozers	Cam attachment	Grinders (gear)
90			Horizontal		Roll	Planing
Method						
1	1 at a time	1 tool at a time	Singly	Without dies—single heat	Traverse	Singly
2	2 at a time	2 tools at a time	In multiple	Without dies—multiple heat	Fixed wheel	In multiple
3	4 at a time			With dies—single operation—single heat	Step-in	
4	4 at a time			With dies—single operation multiple heat	Straight-in or form	
5	5 at a time			With dies—successive oper.—single heat	Combined	
6	6 at a time			With dies—successive oper.—multiple heat	Hand	
7	7 at a time				Lever	
8	8 at a time				Gravity	
9	9 or more at a time					

Size	Greatest Sectional Dimension Inches From	To	Greatest Diameter Feet From	To	Greatest Diameter Inches From	To	Greatest Sectional Dimension—Inches From	To	Greatest Dimension Inches From	To	Diametral Pitch
0.01	0	¼	0	⅓	0	¼	0	¼	0	1	1
0.02	¼	½	⅓	1	¼	½	¼	1	1	2	1½
0.03	½	1	1	2	½	1	1	2	2	4	2
0.04	1	1	2	4	1	1	2	4	4	8	12
0.05	1	1½	4	8	1	1½	4	8	8	12	...
0.06	1½	2	8	16	1½	2	8	16	12	20	...
0.07	2	2½	16	24	2	2½	16	24	20	30	...
0.08	2½	3	24	36	2½	3	24	36	30	45	...
0.09	3	Up	36	Up	3	Up	36	Up	45	Up	...

TABLE IV—B.

SYMBOL Class of Work	K Keyseating	L Lathe (Other Than Turret)	LT Lathe Turret	M Milling (Exclusive of Gear Cutting, Keyway Cutting, Thread Milling and Sawing)	P Planing	Sa Sawing
100	External	Centering	Centering	Flat surfaces—single (external)	Flat surfaces—single	Bars—flat, square and rectangular
200	Internal	Drilling (combined only)	Drilling (combined only)	Flat surfaces—multiple—same or parallel planes	Flat surfaces—multiple—same or parallel planes (external)	
300		Boring and counterboring	Boring and counterboring	Flat surfaces—multiple—parallel (internal)		Bars—round, hexagonal, etc. specials
400		Reaming (combined only)	Reaming (combined only)	Flat surfaces—multiple,—slot	Flat surfaces—multiple—parallel (internal)	Pipes
500		Facing	Facing	Flat surfaces—multiple—right angles	Flat surfaces—multiple—slot	Structural shapes, rails, etc.
600		Turning	Turning	Flat surfaces—multiple—angular	Flat surfaces—multiple—right angles	Plates
700		Thread cutting (combined only)	Thread cutting (combined only)	Flat surfaces—multiple—miscellaneous combined	Flat surfaces—multiple—angular	Sheets
800		Knurling	Knurling	Formed surfaces—regular	Cylindrical surfaces	Ingots, blooms and billets
900		Chamfering and cut-off	Chamfering and cut-off	Formed surfaces—irregular	Templet	Forgings
					Spirals	Castings

SYMBOL Class of Work—Machine	K Keyseating	L Lathe (Other Than Turret)	LT Lathe Turrent	M Milling (Exclusive of Gear Cutting, Keyway Cutting, Thread Milling and Sawing)	P Planing	Sa Sawing
10	Keyseaters	Bench lathe	Single spindle	Plain and universal horizontal	Single crossrail head	Hacksaws—hand
20	Keywaying machines	Engine lathe — 1 toolpost	2 spindles	Plain and universal vertical	Single crossrail head —1 side head	Hacksaws—power—simplex
30	Broaching machines	Engine lathe — 2 toolposts	3 spindles	Manufacturing—hand	Double crossrail head	Hacksaws—power—duplex
40	Milling machines	Heavy-duty lathes	4 spindles	Lincoln—plain, face and duplex	Double crossrail head —1 side head	Band saws
50	Planers	Low-Swing	5 spindles	Planer type (single and multiple head) (Converted planers)	Double crossrail head —2 side heads	Cold and hot saw cutting-off machines
60	Shapers	Boring lathe	6 spindle	Combined horizontal and vertical	Miscellaneous number of heads	Milling machines
70	Slotters	Shell lathe		Open side	Independent housing or extension head	Rotary sheet-metal cutting machines
80	Drills	Shaving machines		Profilers	Open side and draw cut	Shearing machines
90				Die sinkers	Double cutting	Autogenous metal cutting torches
Method						
1	1 at a time—singly	Faceplate	Hand	One vise or fixture	Singly	Singly
2	2 at a time—in multiple	Chuck	Semi-automatic	Two vises or fixtures—reciprocal	Multiple	Multiple
3	3 at a time—in multiple	Between centers	Full automatic	Rectangular	Gang	Gang
4	4 at a time—in multiple	Between centers with follow rest		String	Multiple and gang	Multiple and gang
5	5 at a time—in multiple	Between center and steady rest		Gang	Index centers	
6	6 at a time—in multiple	Collet		String and gang		
7	7 at a time—in multiple	Mandrel — taper and split bush		Circular		
8	8 at a time—in multiple	Mandrel—roller		Indexing		
9	9 or more at a time—in multiple	Special fixture				

Size	Width, Inches From	Width, Inches To	Greatest Diameter Inches From	Greatest Diameter Inches To	Greatest Diameter, Inches From	Greatest Diameter, Inches To	Greatest Dimension of Cut, Inches From	Greatest Dimension of Cut, Inches To	Greatest Dimension of Cut, Feet From	Greatest Dimension of Cut, Feet To	Greatest Dimension of Cut, Inches From	Greatest Dimension of Cut, Inches To
0.01	Up to	1/2	0	1/2	0	1/2	0	1	0	1/2	0	1/2
0.02	1/2	1	1/2	1	1/2	1	1	2	1/2	1	1/2	1
0.03	1	1	1	2	1	2	2	4	1	2	1	2
0.04	1	1	2	4	2	4	4	6	2	4	2	4
0.05	1	1½	4	8	4	8	6	8	4	6	4	8
0.06	1½	2	8	16	8	16	8	12	6	10	8	16
0.07	2	3	16	32	16	24	12	20	10	15	16	24
0.08	3	4	32	64	24	36	20	30	15	25	24	36
0.09	4	Up	64	Up	36	Up	30	Up	25	Up	36	Up

TABLE IV—C

SYMBOL Class of Work	Sh Shaper	Sl Slotting	SM Screw Machine	TC Thread Cutting	W Welding
100	Flat surface—single	Flat surfaces—single	Centering	External	Spot
200	Flat surface—multiple—same or parallel	Flat surfaces—multiple—same or parallel	Drilling (combined only)	Internal	Lap and seam
300	Flat surface — planes (external)	Flat surfaces—multiple—planes (external)	Boring and counterboring		Butt
400	Flat surface — multiple — parallel (internal)	Flat surfaces—multiple—paralle (internal)	Reaming (combined only)		Tee and cross
500	Flat surface—multiple—slot	Flat surfaces—multiple—slot	Facing		Angle
600	Flat surface—multiple—right angles	Flat surfaces—multip'e—right angles	Turning		Upset
700	Flat surface — multiple — angular	Flat surfaces — multiple — angular	Thread cutting (combined only)		Pin
800	Cylindrical surfaces—concave	Cylindrical surfaces—concave	Knurling		Cracks and breaks
900	Cylindrical surfaces—convex	Cylindrical surfaces—convex	Chamfering and cut-off		Additions
Class of Machine					
10	Column or pillar type (crank, geared or rack driven)	Standard type (crank, rack, or screw driven)	Single spindle	Engine lathe	Autogenous
20	Draw cut	Traveling head	2 spindle	Turret lathe	Electric—resistance
30	Traversing head	Portable	3 spindle	Screw machine	Electric—arc
40	Crpssrail head		4 spindle	Threading machine	Electric—La Grange-Hoho
50	Open side		5 spindle	Thread milling machine	Thermit
60	Vertical		6 spindle	Drilling machine	Forging
70	Universal			Tapping machine	
80				Thread rolling machine	
90					
Method					
1	Cross-slide (only)	Singly	Hand	Ordinary lathe tool	Oxy-hydrogen
2	Table—plain—(only)	In multiple	Semi-automatic	Rivett lathe tool	Oxy-acetylene
3	Table—tilting—(only)		Full automatic	Solid die	Incandescent (Thompson)
4	Table—swiveling (only)			Expanding or self-opening die head	Percussive (Westinghouse)
5	Vise with table (plain)			Threading-machine dies	Zerener and Voltex, Bernardos and Slavianoff
6	Vise with table (tilting)			Thread-milling cutter	Stromenger-Slaughter
7	Vise with table (swiveling)			Solid tap	La Grange-Hoho
8	Fixture with table			Collapsing tap	Thermit
9	Fixture without table			Thread rolls	Forging

Size	Greatest Dimension of Cut—Inces From	Greatest Dimension of Cut—Inces To	Greatest Dimension of Cut—Inches From	Greatest Dimension of Cut—Inches To	Greatest Diameter—Inches From	Greatest Diameter—Inches To	Diameter of Threads to Inch		Greatest Dimension of Weld—Inches From	Greatest Dimension of Weld—Inches To
0.01	0	1/2	0	1	0	1/2	14	20	0	1/4
0.02	1/2	1	1	2	1/4	1/2	11½	18	1/4	1/2
0.03	1	2	2	4	1/2	1	8	2	1/2	1
0.04	2	4	4	6	1	1½	..	..	1	1½
0.05	4	8	6	10	1½	2	..	..	1½	3
0.06	8	12	10	16	2	3	..	..	3	6
0.07	12	20	16	24	3	4½	..	..	6	10
0.08	20	36	24	36	4½	7	..	..	10	Up
0.09	36	Up	36	Up	7	Up	..	..		

inch for "Thread Cutting" were used as the size symbol for these operations. There is no confusion with more than one number to represent a section as these are the last figures of the symbol. However, underlined values will eliminate possibly doubtful cases.

Those classes of work which occur under "Boring Mill," "Drilling Machine," "Forging," "Lathe," "Lathe—Turret," "Milling," "Planing," "Shaping," "Slotting" and "Screw Machine" operations and which may be done in a great number of combination machines are placed in a column and bracketed to the rest of the symbol. For example, a drilling machine operation of drill, bore and ream will be represented by

$$\left.\begin{matrix}1\\2\\5\end{matrix}\right\}53.52$$

BB

If there are two advertisements on the same page or advertisements on each side of a page, the page may be filed according to the most important, most useful, or according to the class of advertisement occurring the least

TABLE I. CLASSIFICATION OF OPERATIONS AND SYMBOLS

Symbol		Operations
B	000.00	Broaching
BM	000.00	Boring mill
D	000.00	Drilling
F	000.00	Forging
G	000.00	Grinding
GC	000.00	Gear cutting
K	000.00	Keyseating
L	000.00	Lathe (other than turret)
LT	000.00	Lathe—Turret
M	000.00	Milling
P	000.00	Planing
Sa	000.00	Sawing
Sh	000.00	Shaping
Sl	000.00	Slotting
SM	000.00	Screw Machine
TC	000.00	Thread Cutting
W	000.00	Welding

frequently. A page, having on it the index symbol and any other data desired of the other advertisement and referring to it, may be filed under the index. If a file pocket is used, double advertisements may be kept there until it is reasonably sure that one of the two advertisements will not appear again in another issue as it very often happens.

This system of classification can also be applied when magazines are kept intact. A card file with the cards filed by the index symbol and with the magazine name, date, volume, number and page listed will give all information necessary.

These filing pockets can be used for filing pages from catalogs and manufacturers' production books, magazine articles, time studies and advertisements such as the Fellows Gear Co. give on stub-tooth gears and the Norton Co. on grinding wheels.

One advertiser stated that "production figures mean nothing unless the conditions are all stated," and he then promptly proceeded to omit such insignificant details as feed, depth of cut, cutting speed, material, heat-treat-

TABLE II. OPERATION DIVISIONS AND SYMBOLS

Symbol	Division
000.	Class of work
00.	Class of machine
0.	Method of doing work
.0	Material
.00	Size
.00 Symbol	Manufacturer

ment, presence of scale, carbon steel or high-speed steel tool, tool size, and coolant is used, if any. This fault is not uncommon. If advertising managers will subject proposed advertisements to the question, "Is the data complete?" it will help to eliminate the skeptical idea held by many men that production advertisements are merely circus stunts and that certain factors are purposely omitted in order to show a production which could not be obtained day in and day out.

A milling-operation advertisement should give the following: Machine—type, size; work—inches per minute of feed, inches per revolution of feed, length of cut, width of cut, depth of cut, number of cuts, roughing or finishing cuts, tolerances, method of holding, method of doing; cutter—type, diameter, revolutions per minute, cutting speed, material, coolant, pieces per grinding; material—kind, carbon content or other determining elements, hardness, heat treatment, presence of scale.

TABLE III. MATERIAL SECTIONS AND SYMBOLS

Symbol	Materials
0.0	Miscellaneous
0.1	Aluminum—White metal
0.2	Brass and bronze
0.3	Copper
0.4	Iron—Cast
0.5	Iron—Malleable
0.6	Steel—Cast
0.7	Steel—Carbon up to 0.30%
0.8	Steel—Carbon 0.30% and up
0.9	Steel—Alloy

A similar outline should be worked up for each of the other classes of operations. If this were referred to by the advertising manager, there would be fewer doubt-producing advertisements.

This information could be put in a standard form and made to stand out much more effectively than when covered up by a running account of the job. As far as I know, this may be violating all rules of advertising, but the manufacturer who really has the goods will be able to display them in a form of permanent value, complete and clear, and by so doing will leave no lingering doubts in the minds of thorough, practical men.

A thing worth doing at all is worth doing well. If all production advertisements published had been complete and consequently had been used with confidence, it is safe to say that many thousands of dollars could have been saved by manufacturers not having to determine proper speeds, feeds, etc., and in operating the proper machines at their greatest efficiencies.

Educational Value

There is much to be gained by keeping this file as described. Not only is there shown the choice, range and adaptability of machines, the different set-ups, tooling and methods of doing work, the possible cutting speeds, feeds and depths of cuts with different materials, and other details, but the greatest value of all is to be derived from the general, detached view of the whole field of machine-shop operations.

A Tool for Boring Polygonal Holes

By E. B. Cargill

On page 1246, Vol. 50, of *American Machinist* there is described a device for boring polygonal holes which possibly may be all right for large holes but which is too cumbersome for small ones.

There is a tool manufactured here in Detroit by the Detroit Hexagon Drill Co. which will do this work. It is no larger than a common twist drill of the same size and can be used on any drilling machine with only the addition of a floating drill holder. It is superior to broaching in that a hole may be countersunk or put clear through the stock as desired.

Application of Liberty Engine Materials to the Automotive Industry*

By HAROLD F. WOOD

The success of the Liberty engine program was an engineering achievement in which the science of metallurgy played an important part. The reasons for the use of certain materials and certain treatments for each part are given in this paper and recommendations for their application to the problems of the automotive industry are made by the author.

SINCE the armistice was signed on Nov. 11, 1918, much information has been published concerning the various engineering details of the Liberty engine. It is my purpose to discuss the different types of materials used in the production of this engine, the physical properties of the finished parts and the heat-treatments used to produce them and the application of this information to the automobile, truck and tractor industries.

Carbon-Steel Screw Machine and Carbonized Parts

The most important items to be taken into consideration in the selection of material for parts of this type are uniformity and machineability. It has been demonstrated many times in the last two years that the ordinary grades of bessemer screw stock are unsatisfactory for aviation purposes, due to the presence of excessive amounts of unevenly distributed phosphorus and sulphide segregations. For this reason, material finished by the basic openhearth process was used, in accordance with the following specifications: Carbon, 0.150 to 0.250 per cent.; manganese, 0.500 to 0.800 per cent.; phosphorus, 0.045 maximum per cent.; sulphur, 0.060 to 0.090 per cent.

This material in the cold-drawn condition will show the following minimum physical properties: Elastic limit, lb. per square inch, 50,000; elongation in 2 in., per cent., 10; reduction of area, per cent., 35.

It was found that this material gave as uniform physical properties as did S. A. E. No. 1020 steel and at the same time was sufficiently free cutting to produce a smooth thread and enable the screw-machine manufacturers to produce, to the same thread limits, approximately 75 per cent. as many parts as they could produce from bessemer screw stock.

There are but seven carbon-steel carbonized parts on the Liberty engine. The most important are the camshaft, the camshaft rocker lever roller and the tappet. The material used for parts of this type was S. A. E. No. 1020 steel, which is of the following chemical analysis: Carbon, 0.150 to 0.250 per cent.; manganese, 0.300 to 0.600 per cent.; phosphorus, 0.045 maximum per cent.; sulphur, 0.050 maximum per cent.

The heat-treatment of the carbonized parts used on the Liberty engine consisted in carbonizing at a temperature of from 1650 to 1700 deg. F. for a sufficient length of time to secure the proper depth of case and cool slowly or quench; then reheat to a temperature of 1380 to 1430 deg. F., to refine the grain of the case, and quench in water. The only thing that should limit the rate of cooling from the carbonizing heat is distortion. Camshaft rocker lever rollers and tappets, as well as gear pins, were quenched directly from the carbonizing heat in water and then case-refined and rehardened by quenching in water from a temperature of from 1380 to 1430 deg. F.

The advantage of direct quenching lies in the production of fiber. The rapid cooling causes the strength of the amorphous intercrystalline material to be greater than that of the crystals themselves, which produces the same practical results as are obtained by increasing the amount of amorphous intercrystalline material by refining the grain of the core by a 1625 to 1650 deg. F. quench in oil. The existence of this condition causes the shock-resisting properties of the part to be increased greatly.

Another advantage obtained from rapid cooling from the carbonizing heat is the retaining of the majority of the excess cementite in solution which produces a less brittle case and by so doing reduces the liability of grinding checks and chipping of the case in actual service.

In the case of the camshaft, it is not possible to quench directly from the carbonizing heat because of distortion and therefore excessive breakage during straightening operations. All Liberty camshafts were cooled slowly from carbonizing heat and hardened by a single reheating to a temperature of from 1380 to 1430 deg. F. and quenching in water.

Considerable trouble has always been experienced in obtaining uniform hardness on finished camshafts. This is caused by insufficient water circulation in the quenching tank, which allows the formation of steam pockets to take place, or by decarbonization of the case during heating by the use of an overoxidizing flame. Another cause, which is very often overlooked, is due to the case being ground off one side of cam more than the other and is caused by the roughing master cam being slightly different from the finishing master cam. Great care should be taken to see that this condition does not occur, especially when the depth of case is between $\frac{1}{32}$ and $\frac{3}{64}$ inch.

Carbon-Steel Forgings

Low-stressed carbon-steel forgings include such parts as carbureter control levels, etc. The important criterion for parts of this type is ease of fabrication and freedom from overheated and burned forgings. The material used for such parts was S. A. E. No. 1030 steel, which is of the following chemical composition: Carbon, 0.250 to 0.350 per cent.; manganese, 0.500 to 0.800 per cent.; phosphorus, 0.045 maximum per cent.; sulphur, 0.050 maximum per cent.

To obtain good machineability, all forgings produced from this steel were heated to a temperature of from 1575 to 1625 deg. F. to refine the grain of the steel thoroughly and quenched in water and then tempered to obtain proper machineability by heating to a temperature of from 1000 to 1100 deg. F. and cooled slowly or quenched.

Forgings subjected to this heat-treatment will be free from hard spots and will show a Brinell hardness of 177 to 217, which is proper for all ordinary machining operations. Great care should be taken not to use steel for parts of this type containing less than 0.25 per cent. carbon, because the lower the carbon the greater the liability of hard spots, and the more difficult it becomes to eliminate them. The only satisfactory method so far in commercial use for the elimination of hard spots is to give forgings a very severe quench from a high temperature followed by a proper tempering heat to secure good machineability as outlined above.

The important carbon-steel forgings consisted of the cylinders, the propeller-hubs, the propeller-hub flange, etc. The material used for parts of this type was S. A. E. No. 1045 steel, which is of the following chemical composition: Carbon, 0.400 to 0.500 per cent.; manganese, 0.500 to 0.800 per cent.; phosphorus, 0.045 maximum per cent.; sulphur, 0.050 maximum per cent.

All forgings made from this material must show, after heat-treatment, the following minimum physical properties: Elastic limit, pound per square inch, 70,000; elongation in 2 in., per cent., 18; reduction of area, per cent., 45; Brinell hardness, 217 to 255.

*Paper presented at the summer meeting of the S. A. E. at Ottawa Beach in June, 1919.

To obtain these physical properties, the forgings were quenched in water from a temperature of 1500 to 1550 deg. F., followed by tempering to meet proper Brinell requirements by heating to a temperature of 1150 to 1200 deg. F. and cooled slowly or quenched. No trouble of any kind was ever experienced with parts of this type.

It is my opinion that it was unnecessary to specify two kinds of carbon steel for forgings. If the Liberty program was to be repeated, I would urgently recommend that both S. A. E. Nos. 1030 and 1045 steel be replaced by S. A. E. Nos. 1035 or 1040 steel. Either one of these steels would be ideal for low-stressed carbon-steel forgings, due to the ease of hard-spot elimination and also ideal for important carbon-steel forgings, as it would be possible to obtain the physical properties indicated by using the same quench and a 150 to 175 deg. F. lower tempering temperature. This substitution would reduce the number of carbon steels used as well as appreciably the cost of the finished product.

The principal carbon-steel pressed parts used on the Liberty engine were the water jackets and the exhaust manifolds. The material used for parts of this type was S. A. E. No. 1010 steel, which is of the following chemical composition: Carbon, 0.050 to 0.150 per cent.; manganese, 0.300 to 0.600 per cent.; phosphorus, 0.045 maximum per cent.; sulphur, 0.045 maximum per cent.

No trouble was experienced in the production of any parts from this material with the exception of the water jacket. Due to the particular design of the Liberty cylinder assembly, many failures occurred in the early days, due to the top of the jacket cracking from fatigue. It was found that these fatigue failures were caused primarily from the use of jackets which showed small scratches or die marks at this point and secondarily by improper annealing of the jackets themselves between the different forming operations. By a careful inspection for die marks and by giving the jackets 1400 deg. F. annealing before the last forming operation, it was possible to eliminate the trouble encountered completely.

Highly Stressed Parts

The highly stressed parts on the Liberty engine consisted of the connecting-rod bolt, the main bearing bolt, the propeller-hub key, etc. The material used for parts of this type was selected at the option of the manufacturer from standard S. A. E. steels, the composition of which are given in Table I.

TABLE I. COMPOSITION OF S. A. E. STEELS NOS. 2330, 3135 AND 6130

Steel No.	2330	3135	6130
Carbon, minimum	0.250	0.300	0.250
maximum	0.350	0.400	0.450
Manganese, minimum	0.500	0.500	0.500
maximum	0.800	0.800	0.800
Phosphorus, maximum	0.040	0.040	0.040
Sulphur, maximum	0.045	0.045	0.045
Nickel, minimum	3.250	1.000	.....
maximum	3.750	1.500	.....
Chromium, minimum	.....	0.450	0.800
maximum	.....	0.750	1.100
Vanadium, minimum	.....	.....	0.150

All highly stressed parts on the Liberty engine must show, after heat-treatment, the following minimum physical properties: Elastic limit, pounds per square inch, 100,000; elongation in 2 in., per cent., 16; reduction of area, per cent., 45; scleroscope hardness, 40 to 50.

The heat-treatment employed to obtain these physical properties consisted in quenching from a temperature of 1525 to 1575 deg. F., in oil, followed by tempering at a temperature of from 925 to 975 deg. F.

Due to the extremely fine thread limits used on all threaded parts for the Liberty engine, a large percentage rejection was met by heat-treating the finished parts, due to warpage and slight scaling of threads. To eliminate this objection, many of the Liberty engine builders adopted the use of heat-treated and cold-drawn alloy steel for their highly stressed parts. On all sizes up to and including ⅞ in. in diameter, the physical properties were secured by merely normalizing the hot-rolled bars by heating to a temperature of from 1525 to 1575 deg. F., and cooling in air, followed by the usual cold-drawing reductions. For parts requiring stock over ⅞ in. in diameter, the physical properties desired were obtained by quenching and tempering the hot-rolled bars before cold drawing. It is my opinion that the use of heat-treated and cold-drawn bars is very good practice, provided proper inspection is made to guarantee the uniformity of heat-treatment and, therefore, the uniformity of the physical properties of the finished parts.

The question has been asked many times by different manufacturers, as to which alloy steel offers the best machineability when heat-treated to a given Brinell hardness. I have no definite figures on this matter, but the general consensus of opinion among the screw-machine manufacturers is that S. A. E. No. 6130 steel gives the best machineability and that S. A. E. No. 2330 steel would receive second choice of the three specified.

In the finishing of highly stressed parts for aviation engines, extreme care must be taken to see that all tool marks are eliminated, unless they are parallel to the axis of strain, and that proper radii are maintained at all changes of section. This is of the utmost importance to give proper fatigue resistance to the part in question.

Gears

The material used for all gears on the Liberty engine was selected at the option of the manufacturer from the following standard S. A. E. steels, the composition of which are given in Table II.

TABLE II. COMPOSITION OF STEELS NOS. X-3340 AND 6140

Steel No.	X-3340	6140
Carbon, minimum	0.350	0.350
maximum	0.450	0.450
Manganese, minimum	0.450	0.500
maximum	0.750	0.800
Phosphorus, maximum	0.040	0.040
Sulphur, maximum	0.045	0.045
Nickel, minimum	2.750	....
maximum	3.250	....
Phosphorus, maximum	0.700	0.800
maximum	0.950	1.100
Vanadium, minimum	....	0.150

All gears were heat-treated to a scleroscope hardness of from 55 to 65. The heat-treatment used to secure this hardness consisted in quenching the forgings from a temperature of 1550 to 1600 deg. F. in oil and annealing for good machineability at a temperature of from 1300 to 1350 deg. F. Forgings treated in this manner showed a Brinell hardness of from 177 to 217.

At the option of the manufacturer, the above treatment of gear forgings could be substituted by normalizing the forgings at a temperature of from 1550 to 1600 deg. F. The most important criterion for proper normalizing consisted in allowing the forgings to cool through the critical temperature of the steel, at a rate not to exceed 50 deg. F. per hour. For the two standard steels used, this consisted in cooling from the normalizing temperature down to a temperature of 1100 deg. F., at the rate indicated. Forgings normalized in this manner will show a Brinell hardness of from 177 to 217. The question has been repeatedly asked as to which treatment will produce the higher quality finished part. In answer to this I will state that on simple forgings of comparatively small section, the normalizing treatment will produce a finished part which is of equal quality to that of the quenched and annealed forgings. However, in the case of complex forgings, or those of large section, more uniform physical properties of the finished part will be obtained by quenching and annealing the forgings in the place of normalizing.

The heat-treatment of the finished gears consisted of quenching in oil from a temperature of from 1420 to 1440 deg. F. for the No. X-3340 steel, or from a temperature of from 1500 to 1540 deg. F. for No. 6140 steel, followed by tempering in saltpeter or in an electric furnace at a temperature of from 650 to 700 deg. F.

The question has been asked by many engineers, why is the comparatively low scleroscope hardness specified for

gears? The reason for this is that at best the life of an aviation engine is short, as compared with that of an automobile, truck or tractor, and that shock resistance is of vital importance. A sclerescope hardness of from 55 to 65 will give sufficient resistance to wear to prevent replacements during the life of an aviation engine, while at the same time this hardness produces approximately 50 per cent. greater shock-resisting properties to the gear. In the case of the automobile, truck or tractor, resistance to wear is the main criterion and for that reason the higher hardness is specified.

Great care should be taken in the design of an aviation engine gear to eliminate sharp corners at the bottom of teeth as well as in keyways. Any change of section in any stressed part of an aviation engine must have a radius of at least $\frac{1}{32}$ in. to give proper shock and fatigue resistance. This fact has been demonstrated many times during the Liberty engine program.

Connecting-Rods

The material used for all connecting-rods on the Liberty engine was selected at the option of the manufacturer from one of two standard S. A. E. steels, the composition of which are given in Table III.

TABLE III. COMPOSITION OF STEELS NOS. X-3335 AND 6135

Steel No.	X-3335	6135
Carbon, minimum	0.300	0.300
maximum	0.400	0.400
Manganese, minimum	0.450	0.500
maximum	0.750	0.800
Phosphorus, maximum	0.040	0.040
Sulphur, maximum	0.045	0.045
Nickel, minimum	2.750	....
maximum	3.250	....
Chromium, minimum	0.700	0.800
maximum	0.950	1.100
Vanadium, minimum	....	0.150

All connecting-rods were heat-treated to show the following minimum physical properties: Elastic limit, pounds per square inch, 105,000; elongation in 2 in., per cent., 17.5; reduction of area, per cent., 50.0; Brinell hardness, 241 to 277.

The heat-treatment used to secure these physical properties consisted in normalizing the forgings at a temperature of from 1550 to 1600 deg. F., followed by cooling in the furnace or in air. The forgings were then quenched in oil from a temperature of from 1420 to 1440 deg. F. for the No. X-3335 steel, or from a temperature of from 1500 to 1525 deg. F. for No. 6135 steel, followed by tempering at a temperature of from 1075 to 1150 deg. F. At the option of the manufacturer, the normalizing treatment could be substituted by quenching the forgings from a temperature of from 1550 to 1600 deg. F., in oil, and annealing for the best machineability at a temperature of from 1300 to 1350 deg. F. The double quench, however, did not prove satisfactory on No. X-3335 steel, due to the fact that it was necessary to remove forgings from the quenching bath while still at a temperature of from 300 to 500 deg. F. to eliminate any possibility of cracking. In view of the fact that this practice is difficult to carry out in the average heat-treating plant, considerable trouble was experienced.

The most important criterion in the production of aviation engine connecting-rods is the elimination of burned or severely overheated forgings. Due to the particular design of the forked rod, considerable trouble was experienced in this respect because of the necessity of reheating the forgings before they are completely forged. As a means of elimination of burned forgings, test lugs were forged on the channel section as well as on the top end of fork. After the finish heat-treatment, these test lugs were nicked and broken and the fracture of the steel carefully examined. This precaution made it possible to eliminate burned forgings as the test lugs were placed on sections which would be most likely to become burned.

There is a great difference of opinion among engineers as to what physical properties an aviation engine connecting-rod should have. Many of the most prominent engineers contend that a connecting-rod should be as stiff as possible. To produce rods in this manner in any quantity, it is necessary for the final heat-treatment to be made on the semi-machined rod. This practice would make it necessary for a larger percentage of the semi-machined rods to be cold straightened after the finish heat-treatment. The cold-straightening operation on a part having important functions to perform as a connecting-rod is extremely dangerous.

In view of the fact that a connecting-rod functions as a strut, it is my opinion that this part should be only stiff enough to prevent any whipping action during the running of the engine. The greater the fatigue-resisting property that one can put into the rod after this stiffness is reached, the longer the life of the rod will be. This is the reason for the Brinell limits mentioned being specified.

In connection with the connecting-rod, I wish to emphasize again the importance of proper radii at all changes of section. The connecting-rods for the first few Liberty engines were machined with sharp corners at the point where the connecting-rod bolt-head fits on assembly. On the first long endurance test of a Liberty engine equipped with rods of this type, failure resulted from fatigue starting at this point. It is interesting to note that every rod on the engine which did not completely fail at this point had started. The adoption of a $\frac{1}{32}$-in. radius at this point completely eliminated fatigue failures on Liberty rods.

Crankshaft

The crankshaft was the most highly stressed part of the entire Liberty engine, and, therefore, every metallurgical precaution was taken to guarantee the quality of this part. The material used for the greater portion of the Liberty crankshafts produced was nickel chromium steel of the following chemical composition: Carbon, 0.350 to 0.450 per cent.; manganese, 0.300 to 0.600 per cent.; phosphorus, 0.040 maximum per cent.; sulphur, 0.045 maximum per cent.; nickel, 1.750 to 2.250 per cent.; chromium, 0.700 to 0.900 per cent.

Each crankshaft was heat-treated to show the following minimum physical properties: Elastic limit, pounds per square inch, 116,000; elongation in 2 in., per cent., 16; reduction of area, per cent., 50; Izod impact, ft.-lb., 34; Brinell hardness, 266 to 321.

For every increase of 4000 lb. per square inch in the elastic limit above 116,000 lb. per square inch, the minimum Izod impact required was reduced 1 ft.-lb.

The heat-treatment used to produce these physical properties consisted in normalizing the forgings at a temperature of from 1550 to 1600 deg. F., followed by quenching in water at a temperature of from 1475 to 1525 deg. F. and tempering at a temperature of from 1000 to 1100 deg. F. It is absolutely necessary that the crankshafts be removed from the quenching tank before being allowed to cool below a temperature of 500 deg. F., and immediately placed in the tempering furnace to eliminate the possibility of quenching cracks.

A prolongation of not less than the diameter of the forging bearing was forged on one end of each crankshaft. This was removed from the shaft after the finish heat-treatment, and physical tests were made on test specimens which were cut from it at a point half way between the center and the surface. One tensile test and one impact test were made on each crankshaft, and the results obtained were recorded against the serial number of the shaft in question. This serial number was carried through all machining operations and stamped on the cheek of the finished shaft. In addition to the above tensile and impact tests, at least two Brinell hardness determinations were made on each shaft.

All straightening operations on the Liberty crankshaft which were performed below a temperature of 500 deg. F. were followed by retempering at a temperature of approximately 200 deg. F. below the original tempering temperature.

Another illustration of the importance of proper radii at all changes of section is given in the case of the Liberty crankshaft. The presence of tool marks or under cuts

must be completely eliminated from an aviation engine crankshaft to secure proper service. During the duration of the Liberty program, four crankshafts failed from fatigue, failures starting from sharp corners at bottom of propeller-hub keyway. Two of the shafts that failed showed torsional spirals running more than completely around the shaft. As soon as this difficulty was removed no further trouble was experienced.

One of the most important difficulties encountered in connection with the production of Liberty crankshafts was hair-line seams. The question of hair-line seams has been discussed to greater length by engineers and metallurgists during the war than any other single question. Hair-line seams are caused by small non-metallic inclusions in the steel. There is every reason to believe that these inclusions are in the greater majority of cases manganese sulphide. There is a great difference of opinion as to the exact effect of hair-line seams on the service of an aviation engine crankshaft. It is my opinion that hair-line seams do not in any way affect the endurance of a crankshaft in service, provided they are parallel to the grain of the steel and do not occur on a fillet. Of the 20,000 Liberty engines produced, fully 50 per cent. of the crankshafts used contain hair-line seams but not at the locations mentioned. There has never been a failure of a Liberty crankshaft which could in any way be traced to hair-line seams.

It was found that hair-line seams occur generally on high nickel-chromium steels. One of the main reasons why the comparatively mild analysis nickel-chromium steel was used was due to the very few hair-line seams present in it. It was also determined that the hair lines will in general be found near the surface of the forgings. For that reason, as much finish as possible was allowed for machining. A number of tests have been made on forging bars to determine the depths at which hair-line seams are found, and many cases came up in which hair-line seams were found ⅛ in. from the surface of the bar. This means that in case a crankshaft does not show hair-line seams on the ground surface this is no indication that it is free from such a defect.

In making one Izod impact test on each Liberty crankshaft, a large amount of valuable information was obtained pertaining to the value of impact tests. Considerable confusion arises in attempting to compare impact with fatigue resisting properties, such as determined by the Upton-Lewis, or Stanton machine. The impact test reveals the property of brittleness. Hundreds of tests were made in which it was shown that a crankshaft showing an Izod impact of only 10 to 15 ft.-lb. will show as good results on the Stanton alternating-stress machine as a crankshaft which will show an impact of 50 ft.-lb. Because of results of this nature, the question has been repeatedly raised as to what property, in the actual service of a crankshaft, does the impact test reveal. It is my opinion that the impact test reveals none. This is substantiated by the fact that a number of break-down tests were run on crankshafts which showed impact results as low as from 8 to 10 ft.-lb., and it was unable to cause failure on any one of these tests. Of all of the Liberty crankshafts that failed during the entire program, every shaft showed an impact value of over 50 ft.-lb. If the Izod tests were made using a ⅛-in. radius at bottom of notch on the test specimen which compares more nearly with the radii used in good engineering practice much different results would be obtained.

One important peculiarity of nickel-chromium steel was brought out from the results obtained on impact tests. This peculiarity is known as "blue brittleness." Just what the effect of this is on the service of a finished part depends entirely upon the design of the particular part in question. There has never come to my attention any failure of any nickel-chromium steel parts in the automotive industry which could in any way be traced to this phenomena.

Whether or not nickel-chromium-steel forgings will show "blue brittleness" depends entirely upon the temperature at which they are tempered and their rate of cooling from this temperature. The danger range for tempering nickel-chromium steels is between a temperature of from 400 to 1100 deg. F. From the data so far gathered on this phenomena, it is necessary that the nickel-chromium steel to show "blue brittleness" be made by the acid process. There has never come to my attention a single instance in which basic openhearth steel has shown this phenomena. Just why the acid openhearth steel should be sensitive to "blue brittleness" is not known.

Acid openhearth nickel-chromium-steel forgings which show "blue brittleness" can be put into the proper condition by quenching in water from the tempering temperature. A number of tests were run on Liberty crankshaft steel that was made by the acid process in which the test specimens were allowed to cool at different rates from the tempering temperature. It was found that test specimens cooled in the furnace from the tempering temperature showed an average Izod impact of 8.7 ft.-lb. and those cooled in the air showed an average Izod impact of 29 ft.-lb.; those quenched in oil showed an average Izod impact of 43 ft.-lb. and those quenched in water showed an average Izod impact of 50 ft.-lb. This simply means that all that is necessary to eliminate the presence of "blue brittleness" is to quench all nickel-chromium-steel forgings in water from their tempering temperature. The last 20,000 Liberty crankshafts that were made were quenched in this manner.

Whether or not a crankshaft will show a high or a low impact value depends entirely upon the path of rupture. If an intercrystalline fracture is obtained a low impact value will result. On the other hand, if a transcrystalline fracture is obtained, a high impact value will result. This indicates that the phenomena of "blue brittleness" deals entirely with the condition of the amorphous intercrystalline material.

At the present time there is not enough information to state whether or not this phenomena applies to acid steels other than nickel chromium. A committee has been appointed to work under the direction of the National Research Council to make a detailed investigation of this phenomena.

Piston Pin

The piston pin on an aviation engine must possess maximum resistance to wear and to fatigue. For this reason, the piston pin is considered, from a metallurgical standpoint, the most important part on the engine to produce in quantities and still possess the above characteristics. The material used for the Liberty engine piston pin was S. A. E. No. 2315 steel, which is of the following chemical composition: Carbon, 0.100 to 0.200 per cent.; manganese, 0.500 to 0.800 per cent.; phosphorus, 0.040 maximum per cent.; sulphur, 0.045 maximum per cent.; nickel, 3.250 to 3.750 per cent.

Each finished piston pin, after heat-treatment, must show a minimum scleroscope hardness of the case of 70, a scleroscope hardness of the core of from 35 to 55 and a minimum crushing strength when supported as a beam and the load applied at the center of 35,000 lb. The heat-treatment used to obtain the above physical properties consisted in carbonizing at a temperature not to exceed 1675 deg. F., for a sufficient length of time to secure a case of from 0.02 to 0.04 in. deep. The pins are then allowed to cool slowly from the carbonizing heat, after which the hole is finish-machined and the pin cut to length. The finish heat-treatment of the piston pin consisted in quenching in oil from a temperature of from 1525 to 1575 deg. F. to refine the grain of core properly and then quenching in oil at a temperature of from 1340 to 1380 deg. F. to refine and harden the grain of the case properly, as well as to secure proper hardness of core. After this quenching, all piston pins are tempered in oil at a temperature of from 375 to 400 deg. F. A 100 per cent. inspection for scleroscope hardness of the case and the core was made, and no failures were ever recorded when the above material and heat-treatment was used.

The material used for crank cases, camshaft housings, etc., was of the following chemical composition: Copper, 7.0 to 8.5 per cent.; impurities, 2.0 maximum per cent.; aluminum, remainder.

Test specimens attached to castings which were made

from this alloy showed a minimum tensile strength of 18,000 lb. per square inch, and a minimum elongation in 2 in. of 1.5 per cent. Due to the more or less complicated design of the Liberty crank cases, considerable trouble was experienced in obtaining a satisfactory product. Approximately, 95 per cent. of the crank cases cast for the Liberty engine contained defects which it was necessary to repair before passing the castings in question for production.

Whenever welding operations are carried out on castings for aviation purposes, great care should be taken to see that the casting is preheated to a temperature of approximately 500 deg. F. before the weld is made. The welding stick used should be of approximately the same chemical composition as the casting itself. It is very dangerous to weld any cracks on aluminum castings unless a small hole is drilled at each end. It is also very dangerous to carry out any welding operations upon ribs or bearings of crank cases.

The use of solder of any kind on an aviation aluminum casting is criminal, due to the fact that in this way the doors are thrown wide open to the covering up of defects which might cause the failure of the casting in service. No castings for aviation purposes should ever be repaired for appearance only, as it is very necessary to leave the extent of any defect as apparent as possible for the information of the pilot who is to use the finished engine.

The material used for leakproof parts, such as oil and water pumps, etc., as well as for die and permanent mold castings, such as camshaft bearings, pistons, etc., was of the following chemical composition: Copper, 9.25 to 10.75 per cent.; impurities, 2.00 maximum per cent.; aluminum, remainder.

No physical tests were made on castings of this analysis, due to the fact that different sections of such castings show very uneven physical properties as a result of the chilling of the casting while being made. This is especially true in the case of the permanent mold castings. This alloy is more dense than that used for crank cases and is also more brittle. It is not advisable to use a high-copper alloy on any castings where an appreciable ductility is required.

Babbitt-Lined Bearings

It has been common knowledge among different automotive engineers that the life of an engine depends almost entirely upon the life of its bearings. This is very true in the case of an aviation engine. In the months of October, November and December, 1917, the babbitted bearings used on the Liberty engine were of such poor quality that it was very much doubted whether or not the engine would be as great a success as was expected.

The service conditions on connecting-rod bearings in an aviation engine are entirely different from those encountered on an automobile. Due to the great explosive force used on an aviation engine and the difference in physical properties between the babbitt and the bronze back, the bearings would fail by the babbitt cracking away in spots from the bronze back. The chemical composition of the bronze back and the babbitt lining is not the primary consideration in the production of a satisfactory aviation engine connecting-rod bearing. The thickness of the bronze back and the babbitt, the method of bonding, the uniformity of the bond obtained and the distribution of load on the bearing are all factors which in my opinion are as important, if not more so, than the chemical composition.

The chamical composition of the babbitt lining was as follows: Tin, 85.00 to 87.00 per cent.; antimony, 6.50 to 7.50 per cent.; copper, 6.50 to 7.50 per cent.; lead, 0.20 maximum per cent.

The chemical composition of the bronze back was as follows: Copper, 79.00 to 81.00 per cent.; tin, 9.00 to 11.00 per cent.; lead, 9.00 to 11.00 per cent.; phosphorus, 0.10 to 0.30 per cent.; total impurities, 0.25 maximum per cent.

It was possible to hold the chemical composition of the babbitt lining within the range given, but it was not always possible to hold the composition of the bronze back within the specified range. This was due to the fact that the bronze backs were cast in permanent molds by the centrifugal process. For this reason, the lead content on the outside of the casting would be radically different than that on the inside.

In connection with the babbitting process extraordinary pains must be taken to see that a uniform bond is obtained and that the babbitt lining be so chilled as to give a uniform fine-grained structure. This item is the secret in the production of satisfactory aviation engine bearings. The most important item to watch in the manufacture of babbitted bearings is to hold the babbitt at a temperature of from 800 to 850 deg. F. before being cast and to use a casting ladle designed so as to guard against any likelihood of dross getting into the casting. The casting mold should be chilled in such a way that a very fine-grained babbitt of uniform microstructure is obtained throughout the entire surface of the bearing. When these precautions were completely carried out the bearing troubles on the Liberty engine were completely eliminated.

The most important unlined bushings on any engine are those for the piston pin. On a bushing of this type resistance to wear is the main criterion. The material used for parts of this type was of the following chemical composition: Tin, 10.00 to 11.50 per cent.; zinc, 2.00 to 3.00 per cent.; lead, 0.20 maximum per cent.; impurities, 0.20 maximum per cent.; copper, remainder.

This material, in the cast condition, will show the following minimum physical properties: Elastic limit, pounds per square inch, 19,000; tensile strength, pounds per square inch, 35,000; elongation in 2 in., per cent., 9.

As in the case of the babbitt-lined bearings, even if a bronze bushing meets this specification, it may or it may not give maximum service. To obtain this from an unlined bushing the casting from which it is made must be of a uniform fine-grained structure. This necessitates the employment of exceedingly careful foundry practice and the very careful selection of the raw material from which the alloy is made, as well as the elimination of excessive use of scrap in the foundry practice. Many cases have been found where the wear-resisting properties of a fine-grained bushing are 300 per cent. greater than those of a coarse-grained one.

In addition to the non-ferrous materials previously mentioned, a large quantity of Naval and free-cutting brass rods and unimportant brass castings were used for minor parts on the Liberty engine, such as the priming and oil cups, etc. The materials used on parts of this character were selected at the option of the manufacturer, and no particular metallurgical requirements were specified.

Application to the Automotive Industry

The information given on the various parts of the Liberty engine applies with equal force to the corresponding parts in the construction of an automobile, truck or tractor. I recommend as first choice for carbon-steel screw-machine parts material produced by the basic openhearth process and having the following chemical composition: Carbon, 0.150 to 0.250 per cent.; manganese, 0.500 to 0.800 per cent.; phosphorus, 0.045 maximum per cent.; sulphur, 0.075 to 0.150 per cent.

This material is very uniform and is nearly as free cutting as bessemer screw stock. It is sufficiently uniform to be used for unimportant carbonized parts, as well as for non-heat-treated screw-machine parts. A number of the large automobile manufacturers are now specifying this material in preference to the regular bessemer grades.

As second choice for carbon-steel screw-machine parts I recommend ordinary bessemer screw stock, purchased in accordance with S. A. E. specification No. 1114. The advantage of using No. 1114 steel lies in the fact that the majority of warehouses carry standard sizes of this material in stock at all times. The disadvantage of using this material is due to its lack of uniformity.

The important criterion for transmission gears is resistance to wear. To secure proper resistance to wear a Brinell hardness of from 512 to 560 must be obtained. The material selected to obtain this hardness should be one which can be made most nearly uniform, will undergo forging operations the easiest, will be the hardest to over-

heat or burn, will machine best and will respond to a good commercial range of heat-treatment.

It is a well-known fact that the element chromium, when in the form of chromium carbide in alloy steel, offers the greatest resistance to wear of any combination yet developed. It is also a well-known fact that the element nickel in steel gives excellent shock-resisting properties as well as resistance to wear but not nearly as great a resistance to wear as chromium. It has been standard practice for a number of years for many manufacturers to use a high nickel-chromium steel for transmission gears. A typical nickel-chromium gear specification is as follows: Carbon, 0.470 to 0.520 per cent.; manganese, 0.500 to 0.800 per cent.; phosphorus, 0.040 maximum per cent.; sulphur, 0.045 maximum per cent.; chromium, 0.700 to 0.950 per cent.

There is no question but that a gear made from material of such an analysis will give excellent service. However, it is possible to obtain the same quality of service and at the same time appreciably reduce the cost of the finished part. The gear steel specified is of the air-hardening type. It is extremely sensitive to secondary pipe, as well as seams, and is extremely difficult to forge and very easy to overheat. The heat-treatment range is very wide, but the danger from quenching cracks is very great. In regard to the machineability, this material is the hardest to machine of any alloy steel known.

Composition of Transmission-Gear Steel

If the nickel content of this steel is eliminated, and the percentage of chromium raised slightly, an ideal transmission-gear material is obtained. This would, therefore, be of the following composition: Carbon, 0.470 to 0.520 per cent.; manganese, 0.500 to 0.800 per cent.; phosphorus, 0.040 maximum per cent.; sulphur, 0.045 maximum per cent.; chromium, 0.800 to 1.100 per cent.

The important criterion in connection with the use of this material is that the steel be properly deoxidized, either through the use of ferrovanadium or its equivalent. Approximately 2500 sets of transmission gears are being made daily from material of this analysis and are giving entirely satisfactory results in service. The heat-treatment of the above material for transmission gears is as follows: "Normalize forgings at a temperature of from 1550 to 1600 deg. F. Cool from this temperature to a temperature of 1100 deg. F. at the rate of 50 deg. per hour. Cool from 1100 deg. F., either in air or quench in water."

Forgings so treated will show a Brinell hardness of from 177 to 217, which is the proper range for the best machineability. The heat-treatment of the finished gears consists of quenching in oil from a temperature of 1500 to 1540 deg. F., followed by tempering in oil at a temperature of from 375 to 425 deg. F. Gears so treated will show a Brinell hardness of from 512 to 560, or a scleroscope hardness of from 72 to 80. One tractor builder has placed in service 20,000 sets of gears of this type of material and has never had to replace a gear. Taking into consideration the fact that a tractor transmission is subjected to the worst possible service conditions, and that it is under high stress 90 per cent. of the time, it seems inconceivable that any appreciable transmission trouble would be experienced when material of this type is used on an automobile, where the full load is applied not over 1 per cent. of the time, or on trucks where the full load is applied not over 50 per cent. of the time.

The gear hardness specified is necessary to reduce to a minimum the pitting or surface fatigue of the teeth. If gears having a Brinell hardness of over 560 are used, danger is encountered, due to low shock-resisting properties. If the Brinell hardness is under 512, trouble is experienced due to wear and surface fatigue of the teeth.

For ring gears and pinions I recommend material of the following chemical composition: Carbon, 0.100 to 0.200 per cent.; manganese, 0.350 to 0.650 per cent.; phosphorus, 0.040 maximum per cent.; sulphur, 0.045 maximum per cent.; chromium, 0.550 to 0.750 per cent.; nickel, 0.400 to 0.600 per cent.

Care should be taken to see that this material is properly deoxidized either by the use of ferrovanadium or its equivalent. The advantage of using a material of the above type lies in the fact that it will produce a satisfactory finished part with a very simple treatment. The heat-treatment of ring gears and pinions is as follows: "Carbonize at a temperature of from 1650 to 1700 deg. F. for a sufficient length of time to secure a depth of case of from $\frac{1}{32}$ to $\frac{3}{64}$ in., and quench directly from carbonizing heat in oil. Reheat to a temperature of from 1430 to 1460 deg. F. and quench in oil. Temper in oil at a temperature of from 375 to 425 deg. F. The final quenching operation on a ring gear should be made on a fixture similar to the Gleason press to reduce distortion to a minimum."

One of the largest producers of ring gears and pinions in the automotive industry has been using this material and treatment for the last 2 years, and is of the opinion that he is now producing the highest quality product ever turned out by that plant.

On some designs of automobiles a large amount of trouble is experienced with the driving pinion. If the material and heat-treatment specified will not give satisfaction, rather than to change the design it is possible to use the following analysis material, which will raise the cost of the finished part but will give very excellent service: Carbon, 0.100 to 0.200 per cent.; manganese, 0.350 to 0.650 per cent.; phosphorus, 0.040 maximum per cent.; sulphur, 0.045 maximum per cent.; nickel, 4.750 to 5.250 per cent.

The heat-treatment of pinions produced from this material consists in carbonizing at a temperature of from 1600 to 1650 deg. F. for a sufficient length of time to secure a depth of case from $\frac{1}{32}$ to $\frac{3}{64}$ in. The pinions are then quenched in oil from a temperature of 1500 to 1525 deg. F. to refine the grain of the core and quenched in oil from a temperature of from 1340 to 1360 deg. F. to refine and harden the case. The use of this material however, is recommended only in an emergency, as high-nickel steel is very susceptible to seams, secondary pipe and laminations.

The main criterion on rear-axle and pinion shafts, steering knuckles and arms and parts of this general type is resistance to fatigue and torsion. The material recommended for parts of this character is either S. A. E. No. 6135 or No. 3135 steel, which have the chemical composition given in Tables I and III.

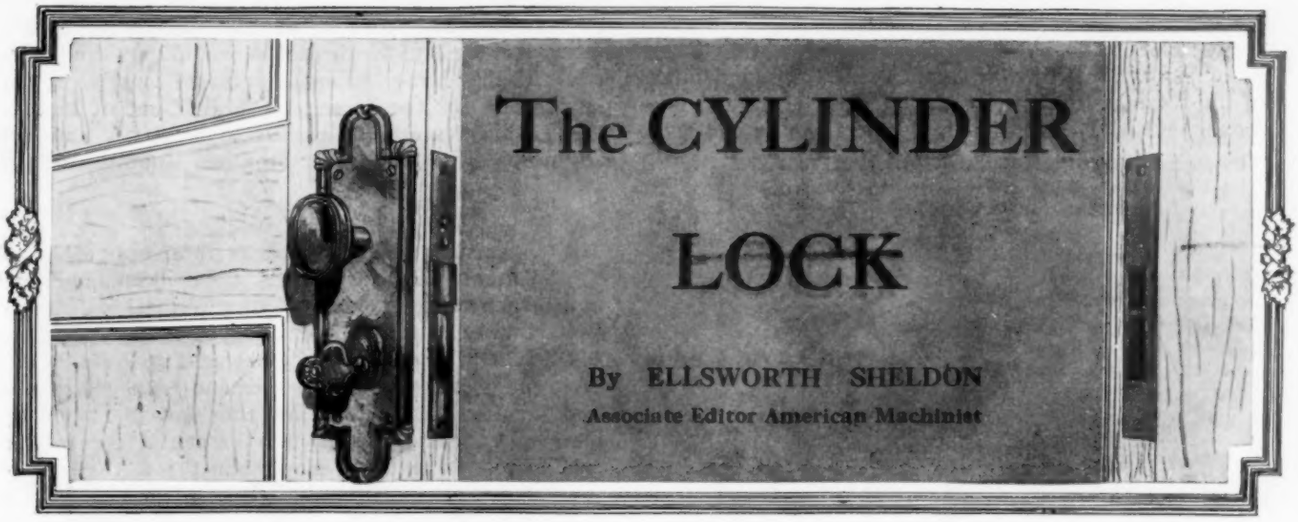
Heat-Treatment of Axles

Parts of this general type should be heat-treated to show the following minimum physical properties: Elastic limit, lb. per square inch, 115,000; elongation in 2 in., per cent., 16; reduction of area, per cent., 50; Brinell hardness, 277 to 321.

The heat-treatment used to secure these physical properties consists in quenching from a temperature of from 1520 to 1540 deg. F. in water and tempering at a temperature of from 975 to 1025 deg. F. Where the axle shaft is a forging, and in the case of steering knuckles and arms, this heat-treatment should be preceded by normalizing the forgings at a temperature of from 1550 to 1600 deg. F. It will be noted that these physical properties correspond to those worked out for an ideal aviation engine crankshaft. If parts of this type are designed with proper sections, so that this range of physical properties can be used, the part in question will give maximum service.

In conclusion, I wish to state that one of the most important developments during the Liberty engine program was the fact that it is not necessary to use a high-analysis alloy steel to secure a finished part which will give proper service. This fact should save the automotive industry millions of dollars on future production.

If the proper authority be given the metallurgical engineer to govern the handling of the steel from the time it is purchased until it is assembled into finished product, mild-analysis steels can be used and the quality of the finished product guaranteed. It was only through the careful adherence to these fundamental principles that it was possible to produce 20,000 Liberty engines, which are considered to be the most highly stressed mechanism ever produced, without the failure of a single engine from defective material or heat-treatment.



The CYLINDER LOCK

By ELLSWORTH SHELDON
Associate Editor American Machinist

II. Slotting the Plug

Following in the wake of improvements in the various forms of locks has been the gentle art of picking them with hairpins, thin-bladed knives, and other "jimmies," but though one may occasionally hear the boast that "he" (a certain mysterious somebody) "can pick any lock that was ever made," the fact of the matter is that the breach between the lockmaker and the lockpicker has been ever widening, until the average present day (or night) burglar will tackle a blank wall with more confidence in his ability to get through than he will bring to the job of picking a modern cylinder lock.

IT IS by no means impossible to "pick" a cylinder lock. As to whether or not an unpickable lock could be made, opinion is divided. One authority says it is impossible; another says it is perfectly practical but that such a lock would have no value, as nobody would buy a lock that absolutely could not be opened without a key. Still another lockmaker says that it not only can but will be done before long and that the locks will meet with a ready sale.

There are advantages, however, in having a lock that can be picked. Sometimes a lock gets out of order and fails to respond to its keys, or the keys may be lost or stolen. In such cases, were the lock unpickable the door would have to be forced, perhaps causing considerable damage and loss.

When necessary, experts from the lockmakers' factory, having special tools for the work and intimate knowledge of the mechanism before them, can pass such locks without a key in a very short time and without damage to lock or door.

Cylinders Interchangeable

Within limits, any cylinder will operate any lock, belonging to its series and if one suspects that there are unauthorized keys to his front door, it is not necessary for him to get a new lock; simply remove the cylinder and substitute another one or have the old one set up to a new combination.

This would seem to make it easy for the casual but clandestine visitor to bring his own cylinder and key with him, but unfortunately for his purpose the door must not only be unlocked but opened and the lock removed before the change can be effected.

The first cylinder locks were made with a key-slot of a plain rectangular section to take a key that was flat and smooth. This form permitted the lockpicker to take a plain flat piece of steel or a number of thin wedges, and by using infinite patience raise one tumbler after another, gaging the distance each was to be lifted by the "feel" of the plug as each tumbler reached the break line, and holding up each successive tumbler while he "felt" for the next one until he had them all in a position to allow the plug to rotate.

The Corrugated Key-Section

To render his job more difficult, the now familiar corrugated key-section was adopted but this did not entirely overcome the liability, as a very thin piece of metal could still be introduced in the keyhole. Its thinness was rather an advantage than otherwise as it could be more rapidly fitted, while, as a burglar does not usually plan to use a key more than once, its wearing qualities would not interest him.

The "Paracentric" Key-Slot

It was not until 1892 that the "Paracentric" key-slot was brought out, which rendered it practically impossible to insert a piece of metal that had not been carefully milled to fit, and as a milling machine was not unusually included in a burglar's kit, the picking of pin-tumbler locks fell into disfavor with this trade.

Owing to the very small increment on any one step of the key necessary to differentiate one lock from another, and the combinations of these differences that can be distributed over the five or six available tumblers, the number of key changes that may be obtained is almost infinite. These changes are further multiplied by differences in the form of the key-slot itself, for though

the key may be of exactly the right contour to raise the tumblers to their correct position it would obviously be of no avail if the key-slot refused it admittance. In the "Paracentric" form of slot, a sketch of which is shown in Fig. 6, one or more projections extend from

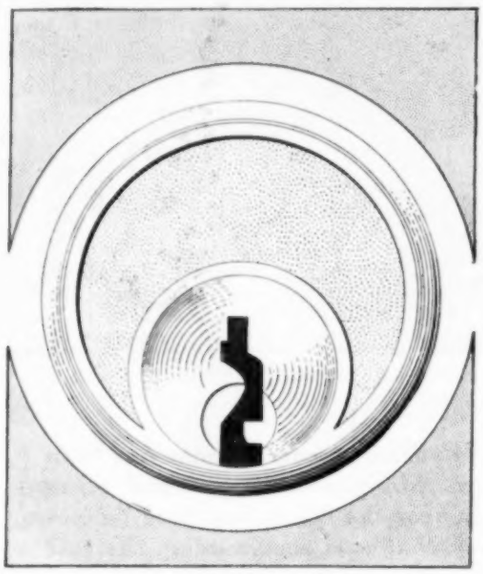


FIG. 6. PARACENTRIC KEY-SLOT

each side to and past the center of the slot in such a manner that no flat piece of metal, however thin, will enter.

Slotting the Plug

The making of a plain slot in the plug was a comparatively simple matter of sawing. The corrugated form demanded a broach of some sort, but still permitted the use of a single tool which was made by soldering or brazing short cutting sections to a long thin ribbon of steel stretched tightly between two supports in the manner of a jigsaw.

The introduction of the "Paracentric" slot, however, necessitated a modification of the broaching tool, as a single broach of the intricate form required and of sufficient length to produce the slot in a single pass would be prohibitive in cost if not impossible to make.

The lock manufacturer's problem was, then, to devise a method, design broaches, and build a machine that would cut any desired form of slot quickly, cleanly, and continuously, without perceptible variation in detail, even though the production ran into hundreds of thousands.

It has been said that given a number of designers working independently upon the same problem, while their methods might vary in detail, in general principles their several solutions would bear a surprising resemblance, and this theory is in part substantiated by the different manufacturers in producing this special machinery.

Two Types of Machine

There are two general types of machine in use, each employing a number of short broaches used in a practically continuous string, each broach cutting its individual part of the slot. The broaches are from 6 to 10 in. in length and $\frac{1}{10}$ in. in thickness. Each broach has teeth cut only upon its advancing edge, the plain portion of each following broach being an accurate fit in the portion of the slot cut by the broaches preceding it. If the plain portion of the succeeding broaches fitted too tightly the broaches would jam and break, while if they were too small or fitted loosely, it would be possible for the broach to "crawl" out of line, producing uncertain and inaccurate work in any event and probably result in later broaches binding and breaking.

A Problem of Production

As it is necessary to produce interchangeable slots by the hundreds of thousands, the making and fitting of broaches becomes a very nice job of toolwork. A feature which experience has proved to be of prime importance is the amount of increment to be allowed to each cutting tooth. The increment found to give the best results is 0.0035 in., and therefore the number of teeth and the spacing of each broach is carefully calculated to this amount; more than this gives the tooth too much to do and tends to clog and break, while less will cause some of the teeth to slide over the metal without taking hold properly, thereby throwing double duty onto the following teeth, and the broach will clog and break from the same cause as before.

Fig. 7 shows the end view of a plug in successive stages of broaching with a sectional view of each broach, seven broaches being used to form the slot shown. Some slots may be cut with four broaches while others of a more complicated section may require 12 or more.

Though tempered by experts in specially designed furnaces, it is too much to expect that a broach will come perfectly straight from the tempering operation, especially when one edge is cut in the manner that these

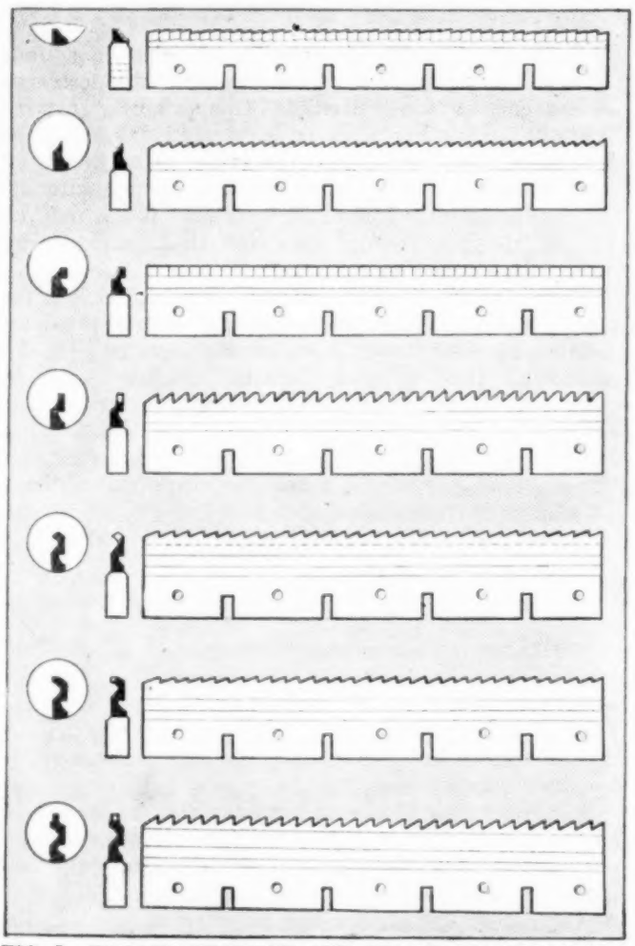
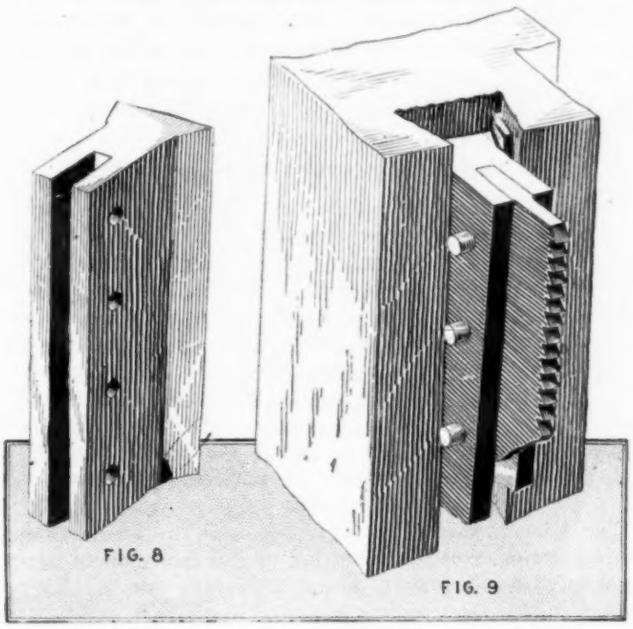


FIG. 7. BROACH SECTIONS AND STAGES OF BROACHING

have to be. To counteract the tendency to warp, the hardeners bend the broaches before hardening in a direction opposite to the one in which experience has shown that they will go in the hardening bath, and so skillful are these workmen that the tools will come



FIGS. 8 AND 9. BROACH HOLDER AND MANNER OF HOLDING IT IN MACHINE

out practically straight. The broach holders are so designed as to correct any error that may remain in this respect.

As will be noted in Fig. 7, saw-cuts are made at regular intervals in the back of the broaches, and between each pair of saw-cuts is a taper-reamed hole to match the corresponding holes in the holder, one of which may be seen in Fig. 8. The slot in the holder is made a close fit for the back of the broach, and when the latter is forced into place and the taper pins driven, it will be drawn into perfect alignment, unless it is so badly warped as to be useless.

The Vertical Broaching Machine

Broaching the slots in the plugs by making separate operations would make the cost prohibitive; therefore, the broaching machines are designed to deliver the broaches in rapid succession in what is practically one continuous movement. In the vertical type of machine is a slide or ram which has a vertical reciprocating movement of about 12 ft. maximum. The ram is driven by open and crossed belts and can be reversed at any desired point in its travel by movable dogs which strike against the belt-shifting lever. The upward or idle stroke of the ram is accomplished at a higher rate of speed. The movement corresponds in every respect to that of a planing-machine table except that it is vertical instead of horizontal.

Extending throughout the length of the ram upon its outer face is a dovetail slot of the same shape and somewhat wider than the tapered base of the broach holder. The latter can be held at any point in the length of the slot by the simple expedient of driving a tapered key along side of it as shown in Fig. 9. Thus any combination or set-up of broaches may be quickly obtained. On the machines of some manufacturers the holder is not used, the broach being set directly into a narrow slot on the face of the ram, and held by gibs and setscrews.

Sliding upon a horizontal runway in a direction to and from the face of the ram, and at a height convenient to the operator, is a small carrier upon or within which is a hardened-steel bushing *A*, Fig. 10, with a small slot at its upper end. This bushing is a close fit for the plugs, and the small slot is for the purpose of locating the key-slot in proper relation to the tumbler holes.

The plugs come to the slotting operation with the tumbler holes drilled, and the operator is provided with a steel pin set in a handle for convenience in handling them. This pin is inserted in the tumbler hole nearest the head of the plug as shown at *B*, the plug then being set into the bushing.

Continuous Operation

The machine runs continuously, and at the moment when the ram is at the upper end of its stroke, the operator pushes the carrier forward where it is automatically locked in position with the plug directly in the path of the descending broaches which pass in swift succession through the metal, leaving a smooth and perfectly formed slot, the shape of which depends upon the set-up of the broaches in use. The time required is about the same as would be consumed in one stroke of a planing-machine table over a similar distance, this distance being the length of the set-up of the broaches plus the clearance at the top and bottom. There is no preliminary cut in the plug, which presents solid metal in the path of the broaches, but a little study of Fig. 7 will show the reader that the slot is really sawed in from the periphery of the plug toward its center, each following broach taking up the work where the preceding broach left off and adding its particular slant to the slot.

As the last broach passes through, the carrier unlocks and is thrown back to allow for the removal of the work and the setting of another blank, the time available being the time required for the upstroke of the ram.

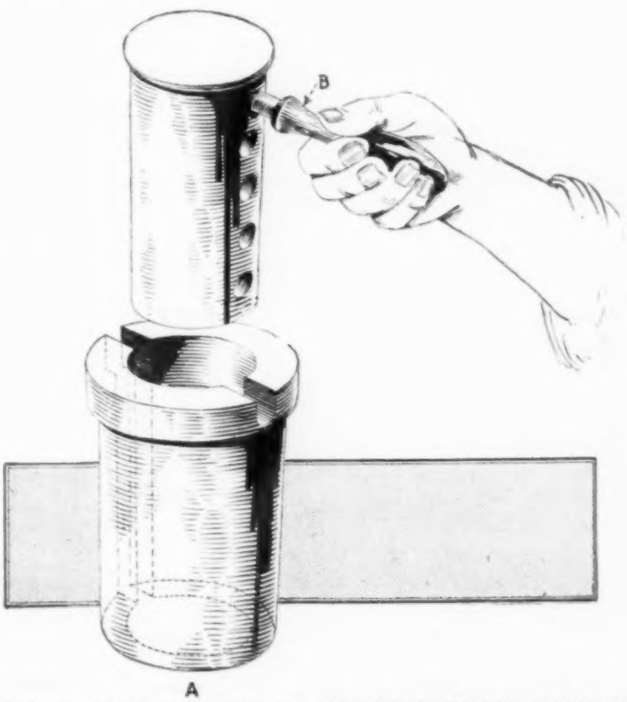


FIG. 10. PLUG-HOLDING BUSHING OF VERTICAL MACHINE

These movements, when but four or five broaches are in use, follow swiftly enough to tax the resources of an expert operator and the output of the machine is, therefore, at its maximum. As more and more broaches are added to the string for producing the more complex forms of slot, the time of each cycle is increased and the operator is obliged to wait upon the machine. It will be readily seen, therefore, that the output is directly dependent upon the complication of the slot produced.

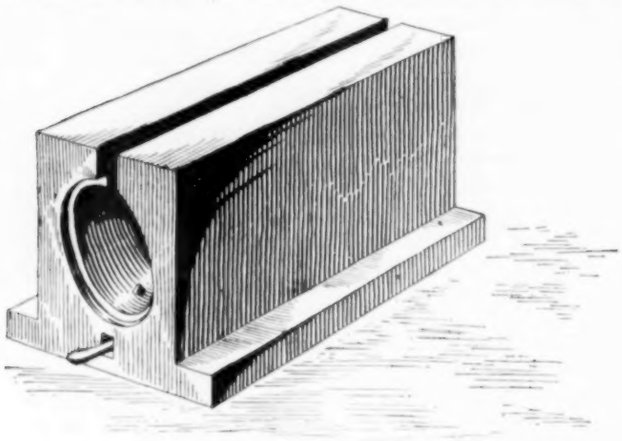


FIG. 11. CARRIER OF THE HORIZONTAL MACHINE

The Horizontal Type of Machine

In the horizontal type of machine the broaches are stationary and the work is moved past them; the production is thus independent of the set-up and is determined by the skill of the operator. The bed or frame of the machine presents a flat table-like surface in which are two runways in the form of large T-slots extending over the length of the table. Each runway has at the bottom a constantly moving chain running over sprockets at each end. Between these two runways and reaching the full length of the machine rises a bracket which, extending for a short distance on either side, overhangs them both, and it is to the under side of this overhang that the broaches are attached in much the same manner as in the other machine, practically the same form of broach being used.

Carriers, one of which is shown in Fig. 11, are fitted to the runways. They have a projection upon the under side which engages special links with which the moving chains are provided at short intervals. Instead of a loose pin the carrier is fitted with a spring-operated locking pin to locate the plug.

It will be readily seen that if the plug be placed in the carrier and the carrier properly set in one of the runways, it will be taken up and carried forward by the chain, and as the overhanging broaches are directly in the path of the advancing plug, the slot will be cut in the same manner as in the vertical machine.

Machine Returns Work to Operator

At the farther end of the machine the carrier passes out of the runway onto the surface of a steel disk which is slowly revolving in a horizontal plane. This disk is provided with stationary fenders or fences that guide the carrier around the semicircle and enter it automatically in the runway on the other side of the overhanging bracket. The chain moving in the opposite direction brings the carrier back to the operating end of the machine, passing any remaining broaches of the set-up on the way. At this end the carrier is deposited upon a rack in a position convenient to the operator who removes the finished plug, inserts a blank and starts the carrier again upon its round.

The cycle of operation in this machine is, therefore, the same whether one or 12 broaches are used, and as plenty of carriers are provided, its production is limited only by the operators' skill in loading and unloading them.

Merits of the Two Methods

There are, of course, advantages and disadvantages in the use of either type of machine. If a long complicated set-up is required, the horizontal machine will deliver the product much faster than the vertical type, which must make a complete stroke for each plug delivered. On the other hand, it is upon the more complicated slots that the greater rigidity made possible by the construction of the vertical machine is of value in preserving their accuracy. As practically all makers of cylinder locks use both types of machines, it is probable that each has its particular field where the other is at a disadvantage.

The adaptation of the cylinder lock to the master-keying system and the evolution of the latter made possible only by this form of lock, will be taken up in a later article.

Details of Gas Consumption for Case-Hardening

By A. J. Smith

Although the advantages offered by the gas-fired furnace for carburizing have been generally recognized in the past from such points of view as close temperature regulation, decreased attendance, and greater convenience, very little information has been published regarding the consumption of gas for this process. It has therefore been a matter of great difficulty to obtain authentic information upon this point, either from makers or users of such furnaces.

In view of this, the details of actual consumption of gas on a regular customer's order job will be of interest. The "Revergen" furnace, manufactured by the Davis Furnace Co., Luton, Bedford, England, was used on this job, and is provided with regenerators and fired with illuminating gas at ordinary pressure, the air being introduced to the furnace at a slight pressure of 3 to 4 in. water gage. The material was charged into a cold furnace, raised to 1652 deg. F., and maintained at that temperature for eight hours to give the necessary depth of case. The work consisted of automobile gears packed in six boxes, the total weight being 713 lb. The required temperature of 1652 deg. F. was obtained in 70 min. from lighting up, and a summary of the data is shown in the following table:

	Cu.Ft. Per Lb. of Load	Total Number of Cu.Ft.
Gas to raise furnace and charge from cold to 1652 deg. F., 70 min.	1.29	925
Gas to maintain 1652 deg. F. for 1st hour	0.38	275
Gas to maintain 1652 deg. F. for 2nd hour	0.42	300
Gas to maintain 1652 deg. F. for 3rd hour	0.38	275
Gas to maintain 1652 deg. F. for 4th hour	0.42	300
Gas to maintain 1652 deg. F. for 5th hour	0.49	350
Gas to maintain 1652 deg. F. for 6th hour	0.49	350
Gas to maintain 1652 deg. F. for 7th hour	0.45	325
Gas to maintain 1652 deg. F. for 8th hour	0.45	325

The overall gas consumption for this run of 9 hr. 10 min. was only 4.8 cu.ft. per lb. of load.

Manufacturing Operations on Pipe Cutters

By J. V. HUNTER
Western Editor *American Machinist*

This article shows some of the operations followed out in the manufacture of a class of tool that is familiar to all having to do with cutting and fitting of pipes for steam, water or gas service.

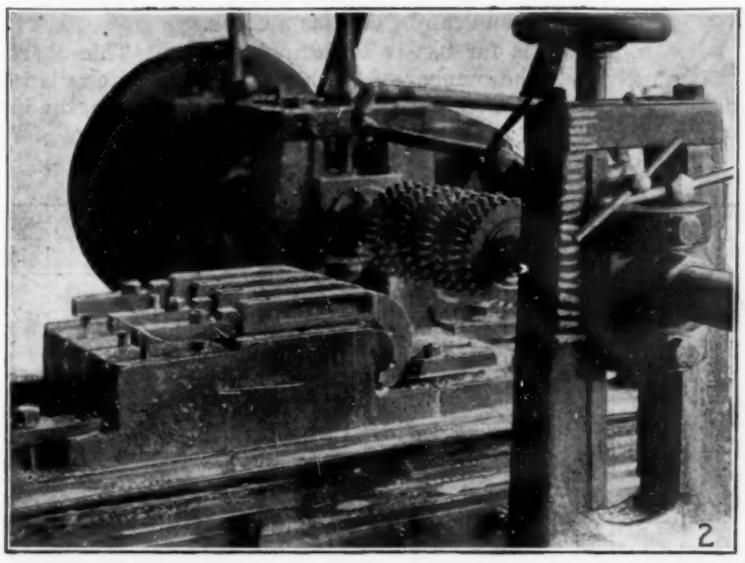
SEVERAL interesting operations in the manufacture of pipe cutters in the shops of the Reed Manufacturing Co., Erie, Penn., which have been developed to facilitate rapid production without sacrificing the quality of output are here illustrated. The cutters are of both the three-wheel type and the single-cutting wheel in combination with two rollers. The machining operations for both are similar.

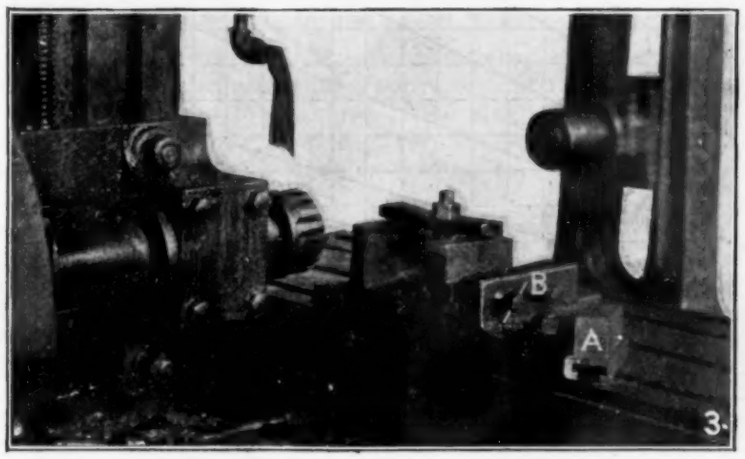
Fig. 1 shows the milling of the inside face on the malleable-iron body casting. Four castings are placed at a time in the holding fixture *A* and are finished at one pass under the milling cutter *B*.

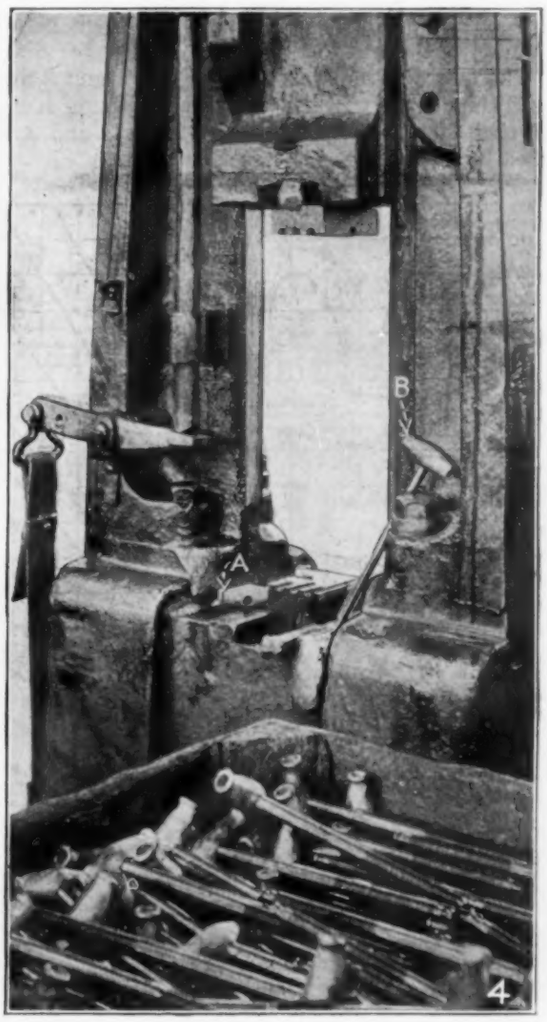
The sides are milled in another fixture, which also holds four castings, as shown in Fig. 2, separated sufficiently to allow the milling cutters to pass between them.

The sliding block *A*, Fig. 3, has a T-shaped slot milled in it, which fits over a corresponding projection on the inside face of the frame, thus providing a means of holding it to the frame while allowing it to slide freely throughout the length of the finished inside face of the latter. After this T-slot is milled the block is mounted in fixture *B* for milling the end faces. It will be noticed that a ready means for locating it in this fixture is provided in the shape of a milled tongue over which the T-slot fits.

The screws are attached to the malleable-iron handles in an interesting manner. The handles are cast with an opening into which the screws may be readily slipped, and the screw has several small notches cut into the handle end to prevent the handle from turning or twisting off after it has been closed in place. The closing operation is performed by laying the screw and handle in a drop-die, as shown in Fig. 4, the upper and lower halves of which have impressions which close tightly about the parts. The impression for the handle itself







FIGS. 2 TO 4. OPERATIONS ON PIPE-CUTTER FRAMES
Fig. 2—Finishing sides of frame castings. Fig. 3—Milling ends of sliding block for pipe cutters. Fig. 4—Closing malleable-handle castings on screws

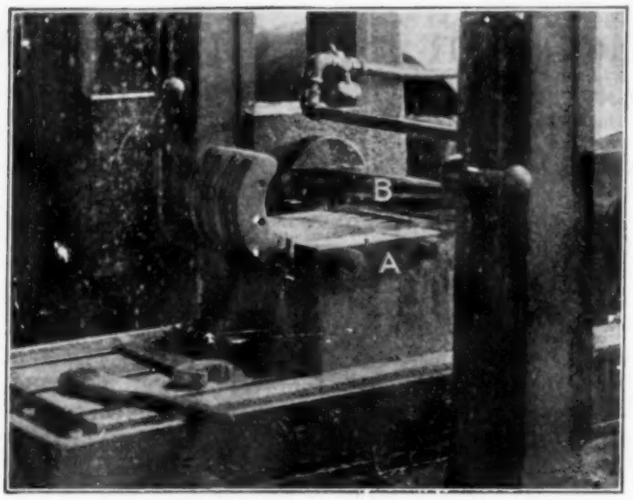


FIG. 1. MILLING THE INSIDE FACE OF PIPE CUTTER

is made small enough so that when a blow is struck, sufficient pressure will be exerted on the malleable-iron casting to squeeze it firmly about the end of the screw. One of the handle castings is shown at *A* and a finished handle and screw at *B*, while in the foreground may be seen a truck loaded with finished handles.

Spur-Gear Diagrams

BY G. C. SUNDBERG

The two diagrams shown in Figs. 1 and 2 are being used considerably in the shops and drafting room of the Wyman-Gordon Co., Worcester, Mass., and are much liked by the men.

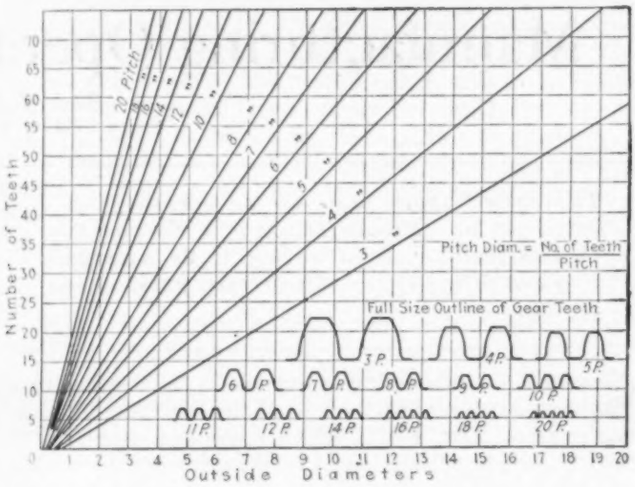


FIG. 1. SPUR-GEAR DIAGRAM FOR SHOP

Fig. 1 gives the outside diameters, number of teeth and pitch of spur gears and was designed to be used mostly in the shop. For instance, when a gear is broken the machinist has simply to measure the outside diameter and count the teeth and the pitch is then derived from the chart. To find the pitch diameter he divides the number of teeth by the pitch, and he is all equipped to cut a duplicate gear. The actual tooth outlines are also shown and can be used as a check.

Fig. 2 is for use in the drawing room. This chart gives us the number of teeth for different pitch diameters or vice versa, and also all other information in regard to spur gears. The chart is also used for checking.

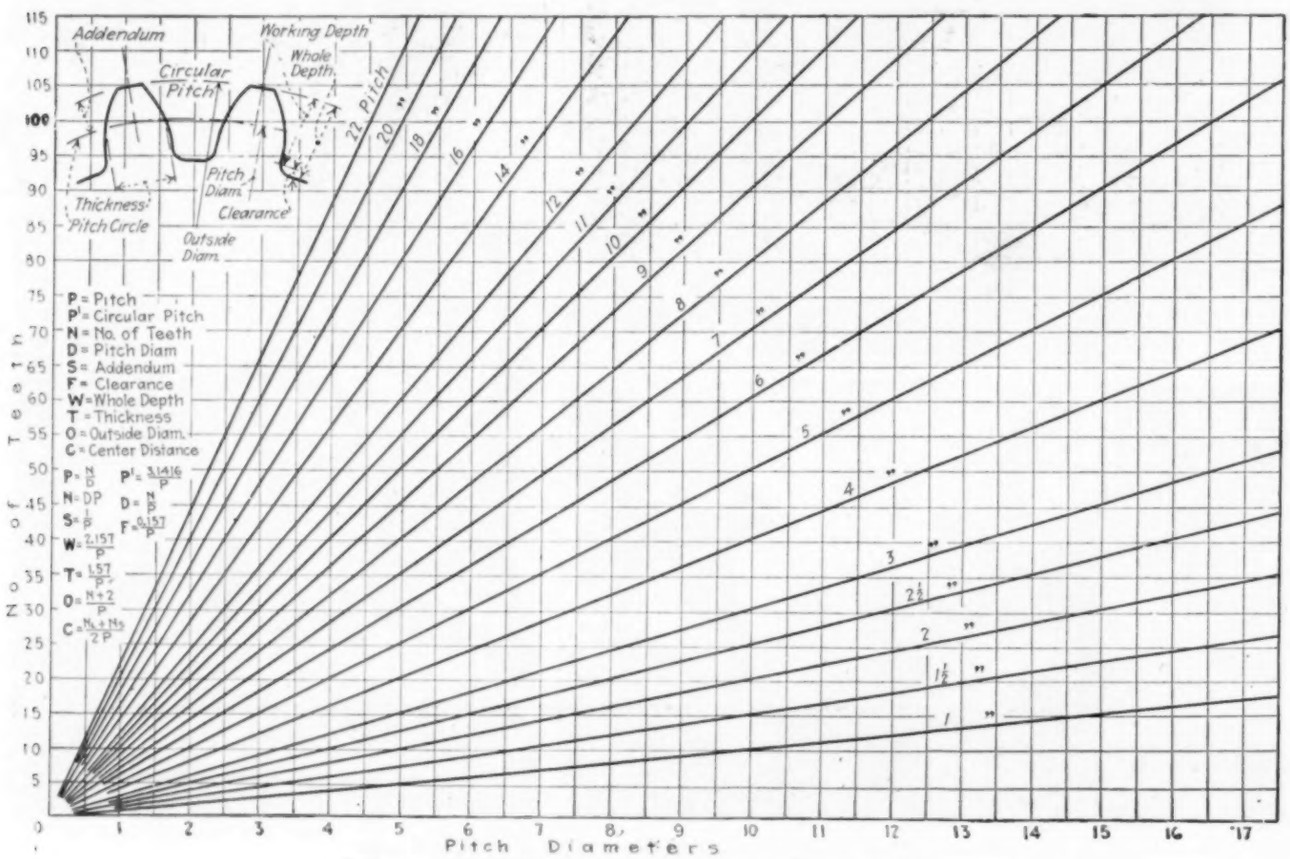
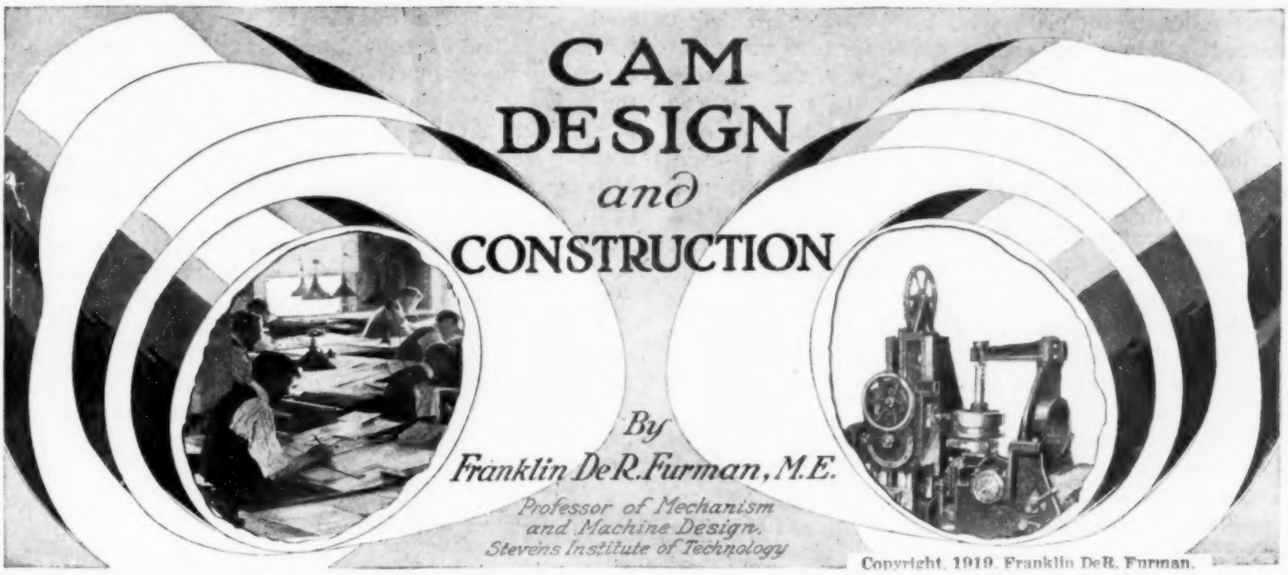


FIG. 2. SPUR-GEAR DIAGRAM FOR DRAFTING ROOM



VI. Miscellaneous Types, Minimum Sizes and Noninterference

The present article deals, first, with the single-disk yoke cam, which is shown to be peculiarly limited in use; second, with the cylindrical cam, in which the size of cylinder is found for a given pressure angle and in which cams are constructed for both straight-line and swinging followers without the use of charts; third, with the timing and noninterference of cams of minimum sizes, and fourth, with the minimum size of cam for producing irregular curves or figures.

YOKE cams are simple radial periphery cams in which two points of the follower, instead of one, are in contact with the working surface. The contact points are usually diametrically opposite to each other. Roller contact is generally used and the centers of the rollers are a fixed distance apart. The yoke cam gives positive motion in both directions and does not depend on a spring or on gravity to return the follower as do all other cams thus far considered, excepting the face cam.

Single-Disk Yoke Cam

Problem 11. Required a single radial cam to operate a yoke follower with a maximum pressure angle of 30 deg.: (a) Out 4 units in 45 deg. turn of the cam, on crank curve; (b) in 4 units in 90 deg. turn of the cam, on crank curve; (c) out 4 units in 45 deg. turn of the cam, on crank curve.

With a single radial cam for a yoke follower data may be assigned only within the first 180 deg. The reason for this will appear presently.

Compute the radius of pitch circle as in ordinary radial cam problems. It is found to be 13.86 units and is laid off at OD, Fig. 50. The pitch surface, $AD, V_1 A_1 V_2$ is found in the usual way, for cams having followers moving in a straight radial line. Then the diametral distance AV_2 will be the fixed distance between the centers of the rollers, and if this distance is laid off on diametral lines as from I_1, K_1 . . . . the points $W, X, \ldots$ on the complementary pitch surface will be located. A size of roller $A\ B$ is next assumed and the working surface $B\ B_2$ is constructed. The maximum radius of the working surface is finally located, as at $O\ B_2$. A small amount is added to this for clearance and the total laid off at $O\ Z$, thus giving the width of yoke necessary for an inclosed cam.

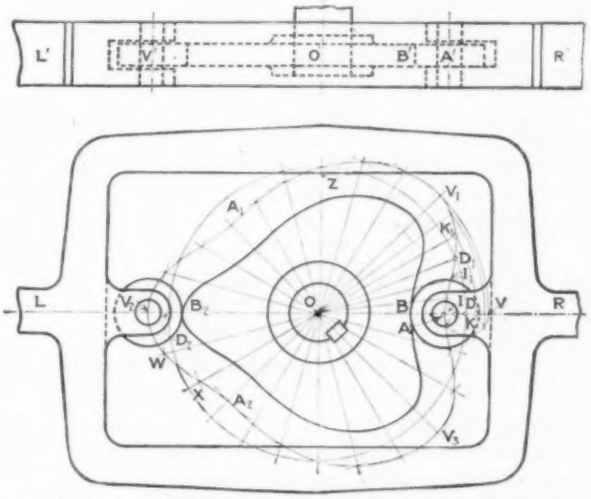


FIG. 50. PROBLEM 11, SINGLE-DISK YOKE CAM

Limited application of single-disk yoke cam—In yoke cams constructed from a single disk the data are limited in two ways: First, data can be assigned for the first 180 deg. only, because the pitch surface for the second 180 deg. must be complementary to the pitch surface in the first 180 deg. Secondly, the data must be such as to have the follower at the extreme opposite ends of its stroke at the 0 deg. and 180 deg. phases. In all other cases increased travel, increased pressure angle and irregular follower velocities will have to considered.

To illustrate the second case assume that item (c) had been changed in the data for problem 11 so as to specify that the follower should remain at rest while the cam turns 45 deg. Then the pitch surface of the cam for the first 180 deg. would have been $AV_1\ A_1\ C$, Fig. 51, instead of $AV_1\ A_1\ V_2$. The diametral distance $A\ C$ would then have been the distance between roller centers, and would have been also the distance used in

determining the complementary pitch surface $C\ E_1\ A_3\ A$ which, it will be noted, approaches closer to O than does $AV_1\ C$. When E_1 of the complementary surface reaches the center line $O\ D$, the center A of the roller will be at E and the roller will have traveled the distance $A\ E$ in addition to the travel $A\ V$ which was assigned. Furthermore the pressure angle will be very high when F crosses the line $O\ D_2$. With the data which gives the pitch surface $AV_1\ C$ the yoke follower will move just twice the assigned distance. This double motion will not be continuous, as the follower will be at rest for a definite period represented by $A_1\ C$. Even if the data were such that A_1 should fall at C there would be a momentary period of rest for the follower at the middle of its stroke.

All of the limitations of the single-disk yoke cam may be avoided by using the double-disk cam, in which the data may be assigned for the full 360 deg. and the primary disk obtained precisely as in any radial single-acting cam. The secondary disk may be obtained by using a constant diametral length of any desired value on the primary pitch curve as a base. The only limitation is that the pitch surface of the secondary cam should not approach any closer to the camshaft center than does the primary pitch surface. A double-disk

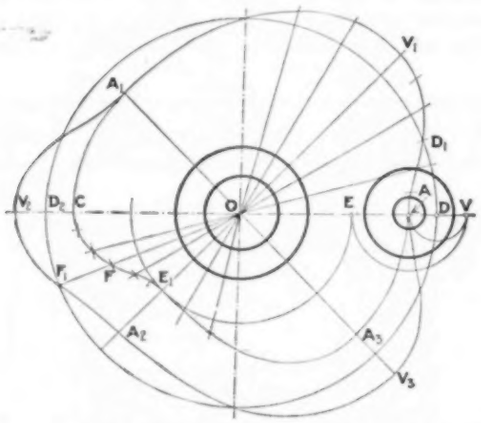


FIG. 51. ILLUSTRATING LIMITED APPLICATION OF SINGLE-DISK YOKE CAM

cam is illustrated in Fig. 52. The data require that the yoke follower move: (a) 6 units to the right on the crank-curve base while the cam turns 150 deg.; (b) 6 units to the left on the crank-curve base while the cam turns 90 deg.; (c) and that the follower remains stationary while the cam turns 120 deg., the maximum pressure angle to be 30 deg. The method of construction is the same as for the ordinary radial cam with the modifications mentioned above.

Cylindrical Cam With Straight-Line Follower

Problem 12. Required a cylindrical cam to operate a reciprocating follower rod: (a) To the right 4 units in 120 deg. on the crank curve; (b) to the left 4 units in 120 deg. on the crank curve; (c) to dwell 120 deg.; the maximum surface pressure angle to be 30 degrees.

The size of cylinder is found by a computation similar to that for radial cams, and in this problem the radius of the cylinder is

$$4 \times 2.72 \times 3 \times \frac{1}{3.14} \times \frac{1}{2} = 5.2\ \textit{units}.$$

This distance is laid off at $O'\ A'$ in Fig. 53 and the circle drawn. The distance $A\ V$, the travel of the follower, is laid off equal to 4 units and subdivided, according to the crank circle, at $H, I. \ . \ . \ .$ The radius of the follower pin is assumed as at $A\ S$ and this distance is laid off at $S\ C$, thus locating the edge of the cylinder. Make $V\ D$ equal to $A\ C$. The circle representing the cylinder is next divided into three 120 deg. divisions at A', M' and Q', as specified.

$A'\ M'$ is divided into six equal parts by the points H', $I', \ . \ . \ .$ which are projected over to meet the vertical construction lines through $H, I \ . \ . \ .$ at $H_3, I_3, \ . \ . \ .$ The latter points mark a curve on the surface of the cylinder. This curve is a guide for the center of the tool which cuts the groove. The drawing of this curve and the construction of the follower pin and rod con-

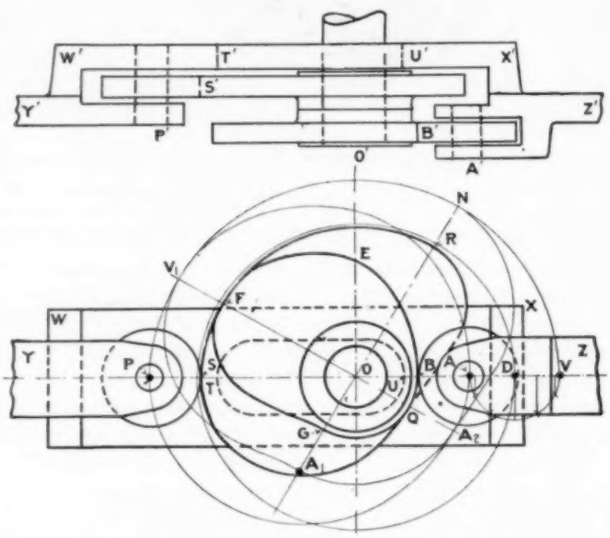


FIG. 52. DOUBLE-DISK YOKE CAM SHOWING YOKE AND ROLLERS

stitute the remaining essential work on this problem. If it is desired to show the groove itself the directions explained in problem 13 will give an approximate method. The follower pin is attached to a follower rod X, Fig. 53, which is guided by the bearings Y and Z. The assigned pressure angle of 30 deg. is shown in its true size at $D\ J\ G$, $J\ D$ being parallel to the direction of motion of the follower rod and $J\ G$ being a normal to the cutting-tool curve $M\ N\ J\ P \ . \ . \ . \ .$ In general the pressure angle will not show in its true size, and if it is then desired to illustrate it the cylinder may in effect be revolved until the correct point of the cutting-tool curve is projected on the horizontal center line. The exact point E where the cutting-tool curve comes tangent to the bottom line of the cylinder may be found by locating E_1 relatively to K_1 and L_1, the same as E' is located relatively to K' and L', and projecting E_1 down to E.

A small clearance is allowed between the end B' of the pin and the inner surface of the groove which is represented by the dash circle passing through F'.

Refinements in Cylindrical-Cam Design. It will be noted that the "maximum surface pressure angle" was given in the data for this problem instead of the term "maximum pressure angle" that has been used thus far. The reason for this is that the pressure angle varies along the length of the pin and is always greatest at its outer end, that is, at the point B in Fig. 53. This

is not important in most practical cases. Further, the term "pitch cylinder" is not mentioned in the simple form of practical construction here used. Since the pitch cylinder should pass through the point where maximum pressure angle exists the pitch cylinder in cams of this type would be one having a radius O' B'. The pitch surface of the cylindrical cam would be a warped surface, known as the right helicoid, and the intersection of this surface with the surface of the cylinder is the curve P A E P R and is the guide curve

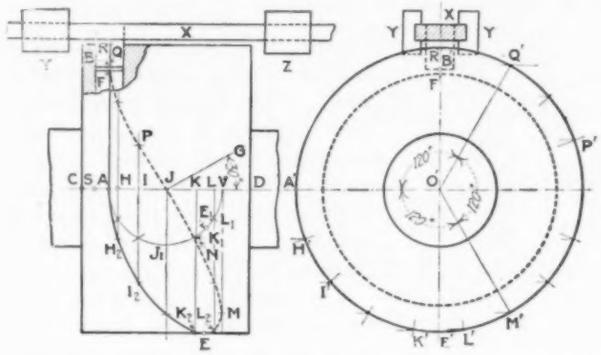


FIG. 53. PROBLEM 12, CYLINDRICAL CAM WITH FOLLOWER SLIDING IN A STRAIGHT LINE

for the cutting tool in milling out the groove for the pin. The sides of the groove are the working surfaces of the cam; they are indicated in the sectioned part of the front view of Fig. 53.

More exact methods for drawing the sides of the groove in a cylindrical cam, together with a more exact method for determining the maximum pressure angle, involve a knowledge of projections and an intricacy in drawing that make such work a proper subject for advanced study, and it will therefore be omitted in this elementary section, as it is unnecessary in most practical work.

Method of Constructing a Cylindrical Cam With a Swinging Follower Arm Without the Use of the Chart

Problem 13. Required a cylindrical cam to operate a swinging follower arm: (a) To the left 40 deg. in 120-deg. turn of the cam on the crank curve; (b) to the right 40 deg. in 120-deg. turn of the cam on the crank curve; (c) dwell for 120-deg. turn of the cam; the length of the follower arm is to be 9 units and the approximate maximum pressure angle is to be 30 degrees.

The diameter for the cylindrical surface is found in the same manner as the diameter of the pitch circle in radial periphery cams. The data in this problem do not give directly the useful travel of the follower and so this value must be found first. The chord of a 40-deg. arc having 9 units radius will be

$9 \times 2 \times \sin 20 \text{ deg.} = 9 \times 2 \times 0.342 = 6.2$ *units.*

If a trigonometrical table is not at hand the arc may be drawn out as in Fig. 54, where half the given angle is laid out at AYJ by the simple expedient of subdividing a 30-deg. arc by means of a dividers. The half chord A D is drawn and measured. It is equal to 3.1 units, thus making the chord of the whole arc of travel equal to 6.2 units. This value is used in obtaining the diameter of the surface of the cylinder as follows:

$$6.2 \times 2.72 \times 3 \times \frac{1}{3.14} = 16.12 \text{ units.}$$

The circle A' Q' M', Fig. 55, is drawn with a radius of 8.06 units.

The 120-deg. angles assigned in the data are next laid out, but not from the center line O R' as in previous problems. In mechanism of all kinds where there is a swinging follower it is a rule, unless otherwise specified, that the swinging pin should be the same distance above a center line at the middle of its swing as it is below at the two extremities of its swing. In this case then the point G, Fig. 54, will be marked midway between J and D and the distance G J laid off at G J in Fig. 55. Y will be the center of swing of the follower arm and the arc of swing of the follower pin will be A J V. J will be as much above the center line as A and V are below. The practical advantage of this detail in the layout is that it gives a maximum bearing length between the follower pin and the side of the groove. The arc A J V, Fig. 55, is next divided at the points marked H, I . . . according to the crank curve assignment, and vertical construction lines are carefully drawn through all these points.

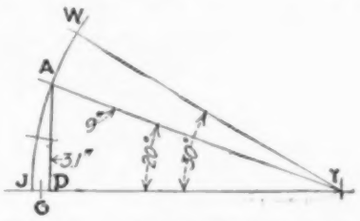


FIG. 54. DETERMINING FOLLOWER TRAVEL IN SWINGING ARMS FOR COMPUTING PITCH DIAMETER

The point A is now projected to A' and the radial line A' O is drawn. This becomes the base line from which to lay off the three assigned timing angles of 120 deg., as shown at A' O M', M' O Q' and Q' O A'. The arc A' M' is next divided into the desired number of equal construction parts, as at H_2, I_2, J_2. . . .

When H_2, Fig. 55, reaches A' the pin A will have swung not only over to H but it will have moved up the distance A' H' measured on the surface of the cylinder. Therefore when H_2 reaches A' it is the line through H_3 (H_2 $H_3 = A'$ H') on the groove center line that will be in contact with the pin center line. For this reason H_3, instead of H_2, is projected over to meet the construction line at H_2. This latter point is on the guide curve for the cutting tool on the surface of the cylinder. Other points are found in the same way. Time may be saved by marking the points A' H' I' J' on the straight edge of a piece of paper and transferring these marks at one time so as to obtain the points I_3, J_3 . . . P_3. . . .

If it is required to show the surface-bounding lines of the sides of the groove it may be done quickly, although approximately, by laying off on a horizontal line, as at I_2, the points I_4 and I_5 at distances equal to the radius of the pin. These will represent points on the curves. If it is required to show the bottom lines of the groove it may be done by projecting from I_7 and finding, for example, I_8 in the same way as I_4 was found.

Chart Method for Laying Out Cylindrical Cam

The use of a chart in laying out cylindrical cams is well known and need not be given here. The chart is scarcely needed when the follower moves in a straight line parallel to the axis of the cylinder, but when the

follower pin moves in an arc, such as *A V*, Fig. 55, the chart method may be a more satisfactory though longer method of construction. The length of the chart for the cylindrical cam is computed in the same way as the chart for simple radial cams.

Noninterference With Minimum Cam Sizes

In machines where two or more cams are employed it is generally necessary to lay down a preliminary diagram showing the relative times of starting and stopping of the several cam followers in order to be assured that the various operations will take place in proper sequence and at proper intervals. The same preliminary diagram is also used to avoid interference and to make clearance allowances for follower rods whose paths cross each other.

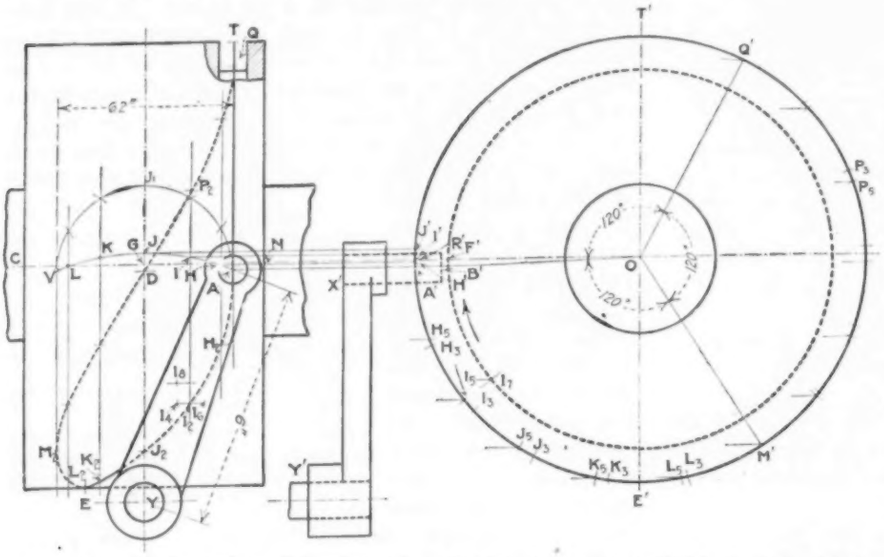


FIG. 55. PROBLEM 13, CYLINDRICAL CAM WITH SWINGING FOLLOWER ARM

Problem 14. Required two cams that will operate the follower rods *A* and *E*, Fig. 56, lying in the same plane, so that: (a) Rod *A* shall move 16 units to *D*, dwell for 30 deg., return 8 units to *B* and again dwell 30 deg., all to take place in 180 deg. turn of the cam. The cam to produce the same motions in the second 180 deg., but in reverse order; (b) rod *E* shall cross path of rod *A* and move 4 units beyound it and back again during the time that rod *A* is moving from *D* to *B* to *D;* all motions to be on the crank curve with maximum pressure angles of 40 degrees.

Before taking up the solution of this problem in detail it should be noted, first, that any convenient type of cam may be used in problems of this kind; second, that usually only general motions of followers or objects are given in the preliminary data, as above, and that the cam designer must supply data and restate the problem in terms of angles for each of the movements after studying the preliminary data with the aid of a timing diagram.

TABLE OF CAM FACTORS

Name of Base Curve	Maximum Pressure Angle and Values of *f*				
	20°	30°	40°	50°	60°
Straight line	2.75	1.73	1.19	0.84	0.58
Straight-line combination*	3.10	2.27	1.92	1.77	1.73
Crank curve	4.32	2.72	1.87	1.32	0.91
Parabola	5.50	3.46	2.38	1.68	1.15
Elliptical curve†	6.25	3.95	2.75	1.95	1.35

* For case where easing off radius equals follower's motion.
† For case where ratio of horizontal to vertical axes of elipse is 7 to 4

The first step leading to a restatement of the problem is to determine the number of degrees in which rod *A*, Fig. 56, may move the 16 units, and also the number of degrees in which it may move the 8 units in order that the pressure angle will be 40 deg. in both cases. Since there are two 30-deg. dwells in the first 180 deg., there will be 120 deg. left for the two motions of which the first motion will require $\frac{16}{24}$ of 120 deg. or 80 deg., and the the second, 40 deg. The length of chart for cam *A* may now be computed as $16 \times 1.87 \times \frac{360}{80} = 134.6$ and laid off as at *AA*, Fig. 57. The height of the chart *AD* is 16 units. The chart is next divided into degrees of any convenient unit, 0, 10 deg., 20 deg.... being used in this case. For the present the base line may be made up of a series of straight lines as at AD_1, D_1D_2, D_2B_1, etc.

The amount of clearance between the moving arms must now be decided upon. Let it be the designer's judgment that the end of the follower rod *E* should lie at rest 1 unit to the left of rod *A*, as shown in Fig. 58, and that rod *E* should not begin to move until the rod *A* is one unit out of the way. Then *A* will be at *C*, Fig. 58, moving down when *E* starts, assuming the rod *E* to be 3 units wide and that it is so placed that its top edge is one unit below *D*. The point *C* is then 5 units from the top of the stroke and if this distance is laid off, Fig. 57, as shown, the line CC_1 is obtained cutting the crank curve, which should now be drawn at *C*. *C* is at the 133-deg. point, and this, then, is the time when the follower *E* should start to move. The total motion for rod *E* is 4 + 5 + 1 = 10 units, assuming width of rod *A* to be 5 units. The time during which this motion can take place outward is 180 deg. — 133 deg. = 47 deg. as represented at E_1E_2, Fig. 57. If the crank curve E_1F is now drawn it will be in-

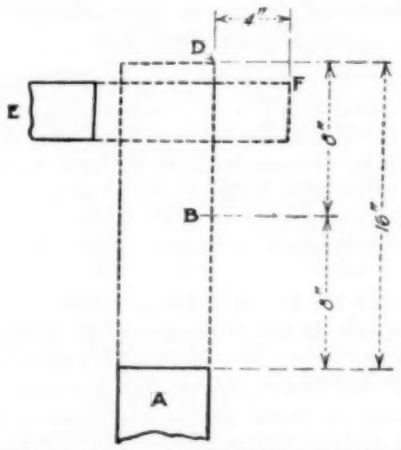


FIG. 56. PROBLEM 14, PRELIMINARY LAYOUT OF DATA FOR THE PROBLEM IN CAM INTERFERENCE

tersected by the one-unit clearance line G_1G at G which represents in this case a rotation of approximately 11 deg. of the cam that drives rod E. The total clearance for the two rods which cross each other's paths is now found to be 3 deg. for cam follower A and 11 deg. for cam follower E, or 14 deg. of the machine cycle. These clearances are indicated in Fig. 57. If it is the judgment of the designer that errors in cutting keyways and in assembling and that the wear of the parts will fall within these limits the cams may now be drawn.

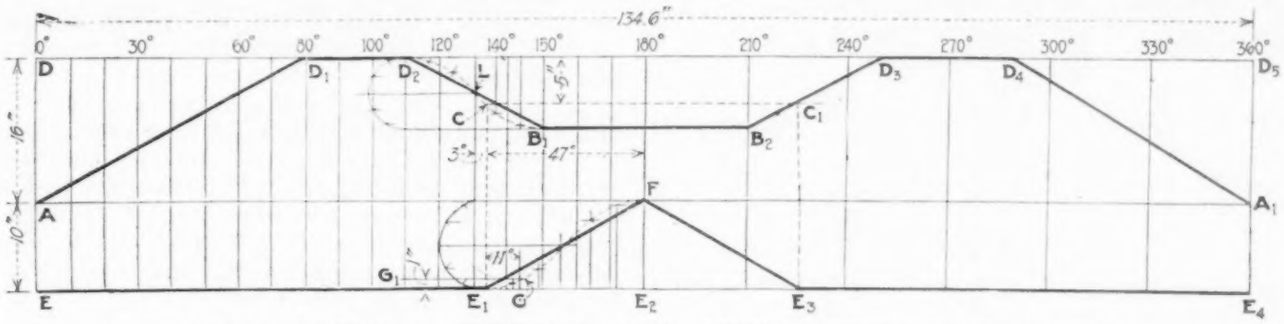


FIG. 57. PROBLEM 14, TIMING DIAGRAM FOR AVOIDING INTERFERENCE OF CAMS

The cam chart for cam E was made the same length as the chart for cam A in order to make clearance allowance. The true length of this chart for a 40-deg. pressure angle would be

$$10 \times 1.87 \times \frac{360}{47} = 143.2 \text{ units},$$

instead of 134.6 as now drawn. If an exact clearance allowance in degrees were required it would be necessary to redraw the crank curve EF, making the distance E_1E_2 equal to $\frac{47}{360}$ of 143.2. It is now $\frac{47}{360}$ of 134.6. With a new and exact drawing the crank curve, E_1G, Fig. 57, would not rise quite so rapidly and the intercept at G would show a small fraction over the 11 deg. taken above. In some problems where the lengths of the true charts differ considerably it may be necessary to redraw this part of the base curve to be sufficiently accurate in obtaining the clearance in degrees.

The radius of the pitch circle for the cam-operating rod A will be $\frac{134.6}{6.28} = 21.4$ units as drawn at HI, Fig. 58. The pitch surface of the cam and the working surface are drawn in the same way as the ordinary radial cams in previous problems. The length of the rod A_1A may be assumed.

The radius for the pitch circle for the cam operating rod E will be $\frac{143.2}{6.28} = 22.8$ and this is laid off at MS. The location of M and the length of the rod NE will either enter into the layout of the framework of the machine in a practical problem or will be determined by the framework if previously laid out. In the present case it will only be necessary, in determining the length of rod NE and the position of M, to make certain that the shafts M and H are sufficiently far apart to keep the cams from striking when turning.

Cams for Reproducing Given Curves or Figures

Cam mechanism for drawing an ellipse. Problem 15, required a cam mechanism that will reproduce the ellipse $ACBD$, Fig. 59, the marking point to move slowly at the extremities A and B of the major axis and rapidly at C and D, the rate of increase and decrease of velocity being uniform.

Divide AC into three parts which are to each other as 1, 3, and 5; CB into three parts which are as 5, 3 and 1 . . . in order that the marking point shall move through increasing spaces in equal times in moving from A to C. . . . For greater accuracy AC would be divided into a greater number of parts.

In devising the mechanism assume that the marking point shall be at the end of a rod which shall be controlled by two component motions that are horizontal and vertical, or nearly so. This suggests the rod AEF, with marking point at A, with vertical motion supplied from a bent rocker attached at F and with horizontal motion supplied from a reversing straight arm rocker LKJ, attached through a link EJ at the point E. The lengths of the links and of the arms of the rockers, and the positions of the fixed centers of the rockers will have to be assumed, the lengths of the arms and links being such that none of them will have to swing through

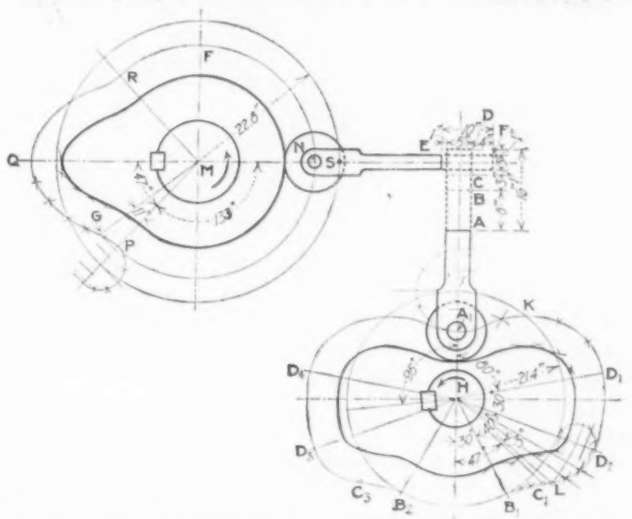


FIG. 58. PROBLEM 14, DESIGN FOR DEFINITE TIMING AND NONINTERFERENCE OF CAMS OPERATING IN SAME PLANE

more than 60 deg. With more than 60-deg. swing the angle between an arm and a link is liable to become too acute for smooth running. Where rocker-arms are connected to links the ends of the rocker should in general swing equal distances above and below the center line of the link's motion, as, for example, the points F and 6 on the arc of swing of F should be as much to the left of the line AM as the point 3 is to the right of it.

Also the arc *3J9* should swing equally on each side of *JT* in order to secure best average pressure angles for the mechanism.

Let each of the rocker-arms be assumed to be controlled by single-acting radial cams. The center of roller *H* will be required to swing on an arc *6H* which, continued, passes through *M*. This gives small pressure angles while *A* is traveling to *B*, especially when *A* is at *C* and is moving fastest. It gives large pressure angle, however, while *A* is traveling from *B* to *D*

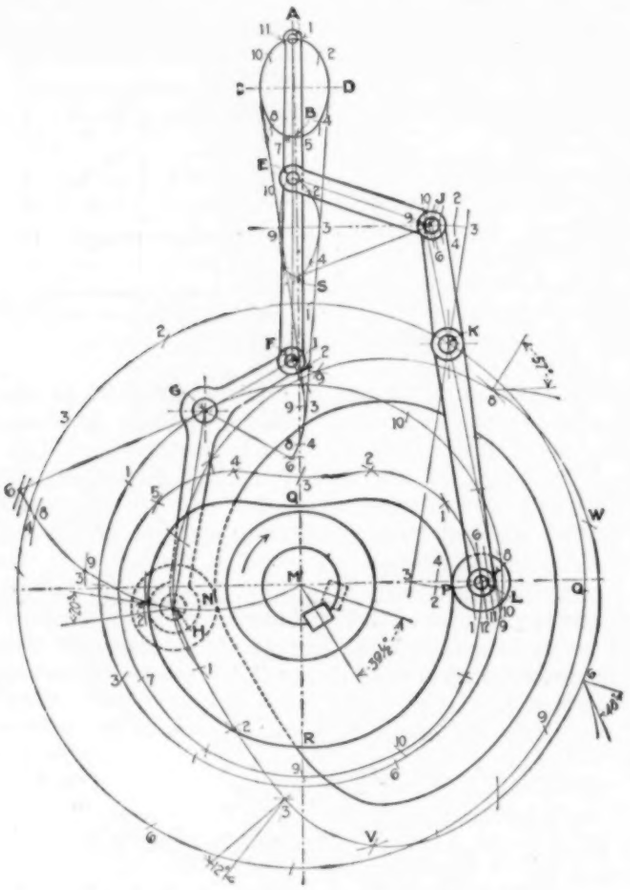


FIG. 59. PROBLEM 15, CAM FOR DRAWING ELLIPSE

to *A*. If *A* is assumed to do heavy work along *ACB* and to run light along *BDA* this is the better arrangement. If *A* did the same work on both strokes it would be better to place the rocker-arm *GH* so that *H* and *6* rested on a radial line. The center of roller *L* will be assumed to travel on an arc whose extremities are on a radial line or nearly so.

With *AF* as a radius and *A, 1, 2, . . .* as centers strike short arcs intersecting *F6* at *F, 1, 2, . . .* numbering the arcs as soon as drawn to avoid confusion later on. Lay off points on *H6* corresponding to those on *F6*.

Inasmuch as the point *H* does not move in accordance with the law of any of the base curves no precise computation can be made for the size of the pitch circle for any given pressure angle, and it may be omitted. Instead a trial minimum radius *MH* of the pitch surface may be assumed. The pressure angles may be then controlled by constructing the pitch surface, *HVW*, and measuring the angles at the construction points. Some of these are shown in Fig. 59, at *H, 3, 6* and *8*, and are 20 deg., —12 deg., 48 deg. and 57 deg. respectively. If these angles should prove unsatisfactory a larger pitch circle or a differently proportioned rocker may be used.

If desired, a computation for an approximate size for the pitch circle may be made as follows: Note the greatest distance traversed by the follower pin *H* during one of the equal time intervals used in the construction. This distance is at *3-4* on curve *MH* extended, and is equal say to 5 units. Assuming that the pin *H* moves over this arc with uniform velocity, and assuming also a pressure angle factor of 1.73 which corresponds to 30 deg., and, finally, noting that 12 equal time periods are used in this problem, the length of cam chart would be

$$5 \times 1.73 \times 12 = 71.4.$$

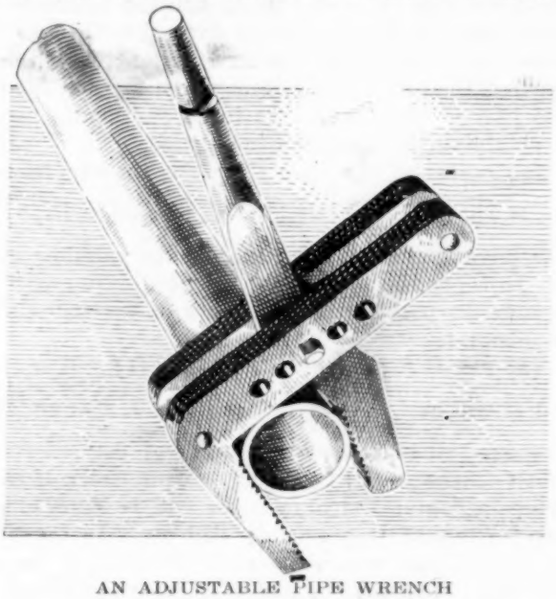
If then a cam chart of this length is drawn and the base curve laid down the position of the pitch line could be determined according to the principles involved in the solution of previous problems, 5 and 9. With the position of the pitch line known in the chart, the pitch circle may be drawn in Fig. 59, with *M* as a center and the position of the arc *MH6* determined.

To construct the second cam take the distance *AE* as a radius and *A, 1, 2 . . .* as centers and mark the points *E, 1, 2. . . .* Again, with the latter points as centers and *EJ* as a radius, mark the points *J, 1, 2 . . .* and transfer these to *L, 1, 2, . . .* With the latter points marked the pitch surface of the second cam *PQR* is constructed in the same way as was the first cam.

An Adjustable Pipe Wrench

BY M. H. POTTER

The drawing shows a simple pipe wrench that may be adapted to a wide range of sizes. The two parts that constitute the fixed jaw are fastened together by means of two bolts or rivets over each of which is slipped a



AN ADJUSTABLE PIPE WRENCH

piece of tube to serve as a spacer. The movable jaw is a neat fit between the sides and swings upon a bolt which is easily removable when it is desired to change the wrench from one size of pipe to another. The length of the sides and the number of holes may be calculated to accommodate the wrench to any size of pipe from the smallest to the largest it is desired to handle.

ARMY ORDNANCE NEWS

The Ordnance Repair Shops at Mehun-Sur-Yevre

By MAJ. GEORGE S. BRADY
Assistant to the Commanding Officer

This is the first account of the Army Ordnance Repair Base in France, for which the plans were ready not long after we entered the war. Changing conditions along the battle lines were reflected in changes of plan back at the bases, but in the end the wisdom of the original scheme was proved by the fact that when the truce was signed the buildings and equipment were approaching completion according to the 1917 design. A few months more would have seen the Ordnance Department in possession of the finest, though not the largest, machine plant in Europe.

FROM an engineering standpoint, particularly from the viewpoint of a mechanical engineer, one of the most remarkable feats of organization and construction of the whole war is demonstrated in the great ordnance repair shops at Mehun-sur-Yevre, France. This plant, Fig. 1, covering more than 22 acres of floor space, besides enormous storage yards, is but a part of a gigantic ordnance project launched in the early part of the war and known as the American Ordnance Base Depot in France. This project was to reach from the base ports to the front lines, with depots and shops at various points. Is-sur-Tille was the advance shop and the base was to be at Mehun-sur-Yevre. The project contemplated all ordnance repair work except that done in the field by the mobile ordnance repair shops and also was to include the supply and reloading of ammunition. The entire project was designed and the material ordered by Ordnance officers and Stone & Webster, engineers, in the summer and fall of 1917 at the Ordnance Office in Washington.

FIG. 3. GUN SHOP NO. 2

These German guns are being overhauled for shipment to the United States for the Ordnance engineering and historical collections. They are being sent to the Aberdeen Proving Ground. The engineering collection is for research work and the historical collection is to be given out to museums.

With the rapid development of the war, the original plans were changed to meet the change of conditions in the field, but when the armistice was signed the original designs for base repair shops were well under way. Soon after our entry into the war, it was found that the great need of the French was for fresh men at the front, and that they were fairly well equipped for the supply and repair of equipment. Their engineers felt that they could handle all re-loading of ammunition for the American Army and that they could reline the guns for an army of 2,000,000 men. Both assumptions were found to be too optimistic by the summer of 1918, when work was rushed on the ordnance shops. The second change was the separation of the ammunition supply from the repair work. Each task was so huge in itself that a separate organization was formed to handle each in the A. E. F. The Supply Division took care of the supply of ammunition, and the Construction and Maintenance Division was in charge of the erection of shops and the overhauling of equipment. The original project for the Mehun shops contemplated 38 steel buildings. The gun-repair plant, comprising two gun shops, Figs. 2, 3 and 4, and a reamer shop, was planned to reline five hundred and ten 75-mm. field guns, one hundred and forty anti-aircraft guns, sixty-five 4-in. guns, one hundred and eighty 155-mm. howitzers, two hundred and fifty 155-mm. guns and one hundred 9.2-in. howitzers per month, a total of 1245 guns per month. The equipment of these two gun shops included 209 gun-boring lathes, 66 grinding machines, 24 engine lathes, two gun-shrinking furnaces and 34 smaller machine tools. All of this machinery was delivered and was being set up when the armistice was

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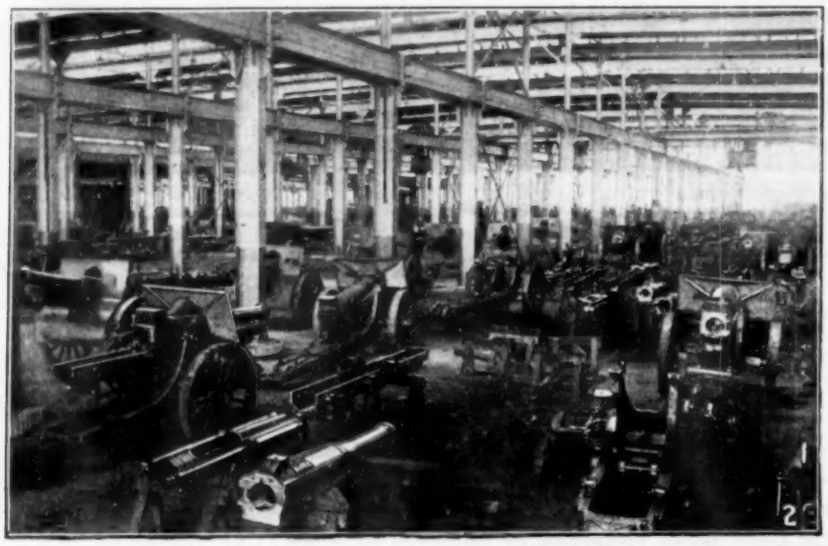

FIG. 2. GUN SHOP NO. 1

This shows American artillery, 155-mm. howitzers, in process of being overhauled for shipment to the United States. Part of one end of this building is open because two columns were lost at sea in a ship sunk by submarines.

signed. The carriage repair plant, Fig. 5, with a combined equipment of 370 machine tools, was intended to repair 2000 gun vehicles per month. The carriage machine shop was completely installed and had a force of 300 men employed on Nov. 11. The carriage-erecting shop was built and the machinery was being set up. The small-arms shop was designed to overhaul and repair 150,000 rifles, 5000 pistols and 20,000 machine guns per month. This building was not erected, but a small-arms repair plant, Figs. 6 and 7, of about one-quarter this capacity was in full operation in the carriage-repair building with 200 men employed. The entire ordnance repair shops

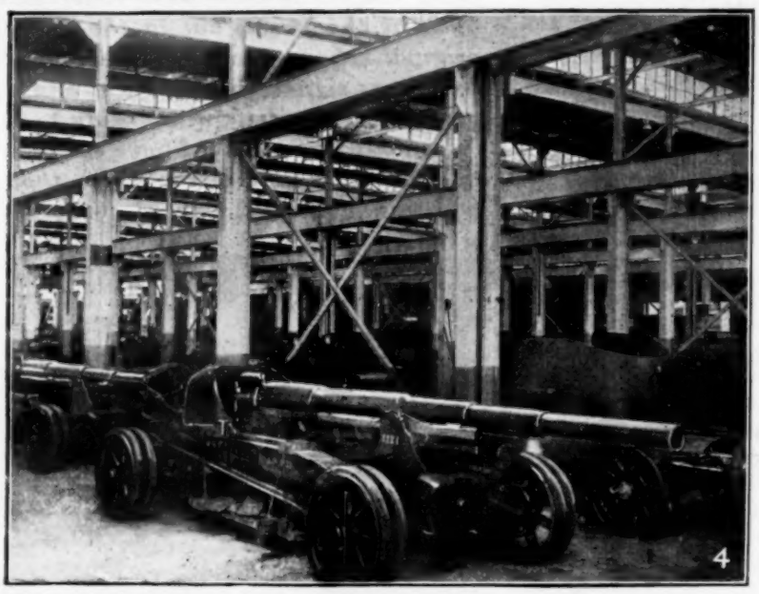

FIG. 4. GUN SHOP NO. 2 AND 155-MM. G. P. F. GUNS

This view shows the construction of the buildings and two of the famous 155-mm. G. P. F. guns which were manufactured by the French and sold to our Government. One hundred and fifty of them have been overhauled and sent to the United States.

FIG. 5. THE CARRIAGE MACHINE SHOP

This shows the 75-mm. guns of the Eighty-ninth Division being overhauled for shipment to the United States

as completed on Nov. 11, when all construction work ceased, consisted of the following: Two gun shops, each 245 ft. x 600 ft., machinery being installed; one reamer shop 180 ft. x 240 ft., machinery being installed; one carriage machine shop 226 ft. x 500 ft., fully equipped; one carriage-assembly shop 240 ft. x 500 ft., machinery being installed; two storehouses, each 240 ft. x 500 ft., in full operation; one forge and foundry 160 ft. x 245 ft., in full operation; one wood-working shop 200 ft. x 320 ft., in full operation, and one additional storehouse was being constructed. These buildings are of all metal construction. When the armistice was signed, the carriage machine shop and the forge shop were employed on the manufacture of tools and parts for mobile repair shops, and parts for the French 75-mm. gun, it not being considered advisable to overhaul artillery until the gun and carriage erecting shops were installed. The small-arms shop was overhauling and reshipping rifles, pistols and machine guns, and the storehouses were distributing supplies to American units in all parts of France. Late in November it was determined to send all artillery and ordnance to the Mehun shops from the battlefields for overhauling, repair and reshipment to the United States. The two gun shops, carriage machine shop and carriage erecting shop, were at once prepared

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as an artillery repair plant. These buildings contain 20 traveling cranes of 10- and 15-ton capacities. The artillery plan was to overhaul all pieces, clean, repair and paint them, and to crate all guns up to and including the 75-mm. The small-arms program was to clean, grease and box all serviceable rifles, and to dismount all those unserviceable, cleaning all parts that were in good condition, and boxing the parts without reassembling. All machine guns were to be dismounted and put in serviceable condition. The first artillery was received on Dec. 6 and the program has been carried out as planned. Up to Apr. 12 more than

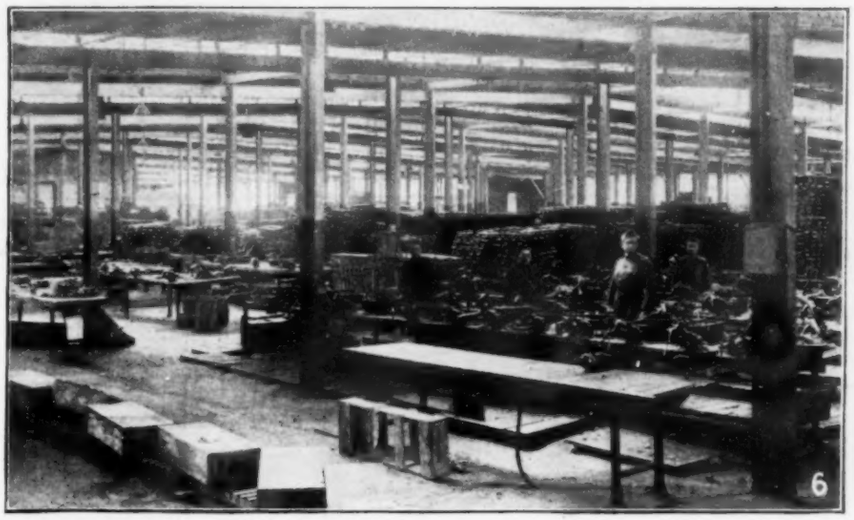

FIG. 6. ONE VIEW OF THE SMALL-ARMS SHOP

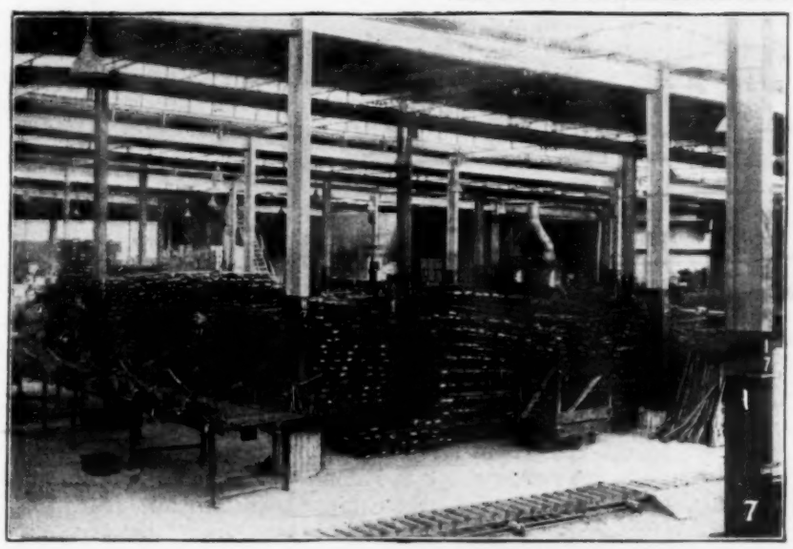

FIG. 7. ANOTHER VIEW OF THE SMALL-ARMS SHOP

500 cars of salvaged artillery and small arms have been received at Mehun and over 2400 carloads were overhauled and reshipped This includes 750 French 75-mm. guns which were dismounted, put in first-class condition, and the mechanisms boxed for shipment. Some other items overhauled and shipped to the United States in this period were: 220—155-mm. howitzers; 133—155-mm. G. P. F. guns; 99—8-in. howitzers; 24—9.2-in. howitzers; 49—4.7-in. guns; 130,000—United States rifles; 40,000 German rifles; 3600—light Browning machine guns; 3000—various types heavy machine guns; 6300—pistols and revolvers of various makes.

In addition there has been repaired and shipped more than 100,000 bayonets and rifle parts in such quantities as 76,000 bolts, 57,000 receivers, 73,000 upper bands, 71,000 lower bands, 62,000 bolt stops. The crating and boxing of this material required over 4,000,000 board feet of lumber, which was cut by American engineers in French forests. The crates and boxes were standardized and made in quantities in the woodworking shops, Fig. 8. A force of 160 Ordnance mechanics and 50 Chinese laborers are employed in this wood shop. The optical-instrument repair shop covers a space of 60 x 80 ft. in the carriage assembly building and has a force of 60 men employed. All artillery sights, quadrants, clinometers,

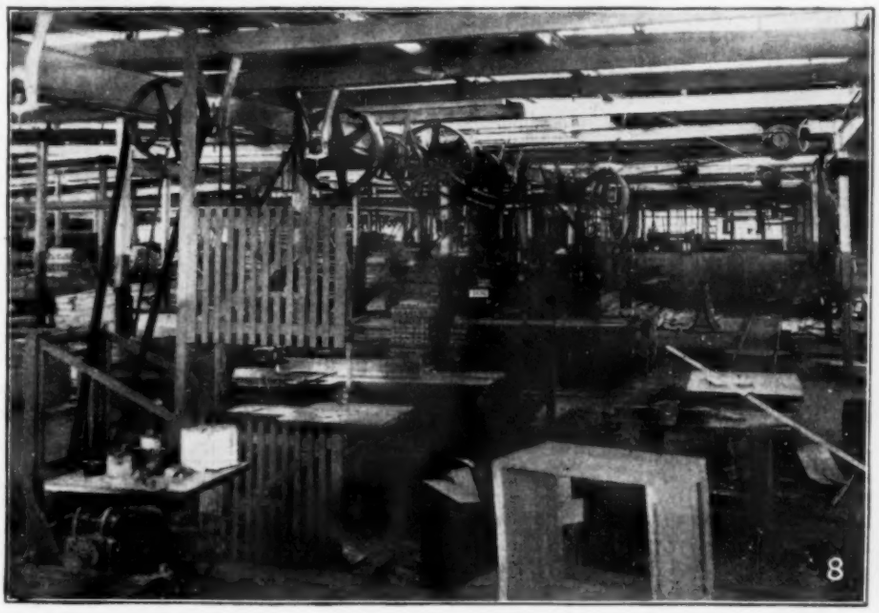

FIG. 8. THE WOODWORKING SHOP

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and other valuable instruments are overhauled, put in serviceable condition and boxed for shipment.

The Mehun storehouses, Fig. 9, are unparalleled in the variety of their stores. Besides supplying the shops with tools and materials for operation, they furnished supplies to the mobile ordnance repair shops, to artillery and truck parks, and to advance shops. One of these storehouses contains 17,300 different items.

A most remarkable thing in the building and operation of these shops is the personnel factor. During the construction period Mehun was a concentration camp for Ordnance troops. All Ordnance men arriving in

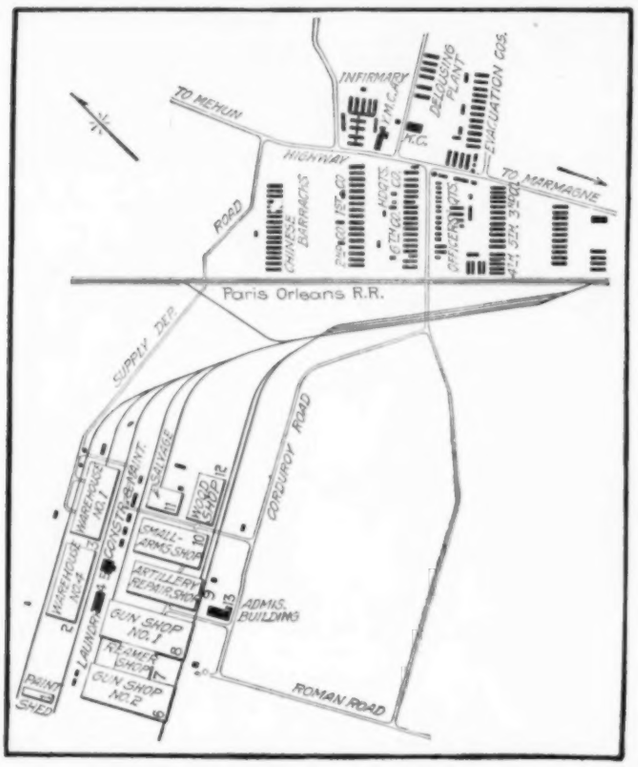


FIG. 1. PLAN OF SHOPS AND CAMP

France were sent to Mehun for classification and distribution to the armies and advance shops. While awaiting assignment they were used in the erection of the shops. Only 12 officers were considered as permanently assigned for the construction work and administration of the companies. The personnel turn-over of officers and men was 100 per cent. per month. The first Ordnance company of 250 men arrived in February, 1918. From June 1 to Nov. 11, the average number of men for construction and operation of the shops and warehouses was about 2000. Since the armistice, the personnel used to overhaul the artillery consists of the Ordnance men passing through Mehun en route to America. The Camp is now a concentration point for Ordnance personnel returning to the United States and the men are used for the work in the shops while awaiting their turn for evacuation. The men are rated for return to the United States by a percentage system according to the length of service and other factors. The personnel turn-over is now 60 per cent. a month. The average force at work in the shops since December

FIG. 9. ONE SECTION OF A STOREHOUSE
This one building contains 17,300 different items all carefully stored and classified as in the best plants in the United States

has been about 2400 Ordnance men, 200 French women and 800 Chinamen. The enlisted personnel of the Ordnance in the A. E. F. is made up of the highest type of mechanics and artisans. Over 9000 skilled men, representing more than 60 trades, were enlisted in November and December, 1917, for this work. In spite of the constantly shifting personnel, it has been possible to maintain a remarkably high standard as a military camp. A fine 30-piece band, composed entirely of Ordnance men, has been maintained, though evacuation changes its members constantly; an eight-page camp newspaper is printed in the print shop at the repair plant, and a camp laundry, Fig. 10, handling over 20,000 pieces a week was installed and is operated by Ordnance men.

Had the war continued for a few months longer, until the completion of the gun and tractor shops, the ordnance repair shops at Mehun would have been the finest and most completely equipped, though not the largest machine plant in Europe. It would have employed 10,000 men. It is one of the greatest expressions of American determination to prosecute the war to a successful end no matter what the cost or the time needed.

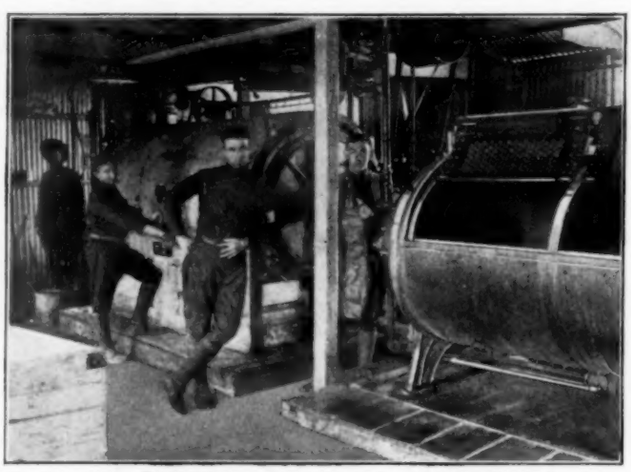


FIG. 10. THE CAMP LAUNDRY
This shows the machine room where over 20,000 pieces per week are washed, the force working in two 8-hour shifts. The soldiers are charged 30 centimes (6 cents) for 10 pieces. This price covers the cost of the soap.

The Fixing of Resale Prices—II

BY CHESLA C. SHERLOCK

The extent of a manufacturer's right to specify the resale prices of his manufactured goods has occupied the attention of the courts for many years. This article reviews some of the early decisions rendered in trade contract cases.

AS MENTIONED in the preceding article, it is common practice for manufacturers to stipulate the resale price of their commodities which have been made by secret and patented processes. In cases involving breach of trade contracts covering such articles by the seller, the court has, as a rule, upheld the manufacturer as will be seen in the following abstracts.

In an early California case involving a contract entered into by a certain manufacturer of olive oil with his trade, the court said:

The contract here relied on does not relate to any olive oil except that manufactured by the plaintiff. There is no suggestion that this comprises all, or any large proportion, of the olive oil manufactured or sold in the market supplied by the plaintiff. While the plaintiff alleges that he manufactures oil by a process of his own discovery, there is nothing exclusive in the product resulting from this discovery. All that he claims for his oil is that it is pure and wholesome. The court must assume, as a matter of common knowledge, that others may and do manufacture pure olive oil in considerable quantities.

Under these considerations, we see no reason why the contract alleged by the plaintiff should not, as between the parties to it, be held to be valid. It violates no canon of public policy. By its terms the buyer is not precluded from engaging in any lawful trade. He may sell other olive oil at any price and on any condition satisfactory to him. The producer was, in the first instance, under no obligation to sell his oil, and, when he did sell it, had the right to exact, as part of the consideration for the sale, a promise from the purchaser that he would not sell it for less than a stipulated price. There is nothing either unreasonable or unlawful in the effort of a manufacturer to maintain a standard price for his goods. It is simply a means of securing the legitimate benefits of the reputation which his product may have attained. Contracts similar to the one under discussion have been considered in a number of cases, and have been generally upheld where, as here, they had no tendency to create a monopoly.

While this case deals with olive oil, the principles discussed are as applicable to machinery and steel springs as they are to olive oil. And this case is a very good example of the earlier view, that so long as attempts to control resale prices stood in no immediate danger of creating a monopoly, they would be upheld as entirely satisfactory and legal; the inference being that if they showed too lusty a growth that the courts would not be so lenient toward them.

In a Massachusetts case, decided about the same time, the court said:

When, as here, there is a secret composition, which the defendant presumably would have no chance to sell at a profit at all but for the plaintiff's permission, a limit to the license in the form of a restriction in the price at which he may sell, is proper enough.

Strangely enough, this one little sentence from the Massachusetts decision has caused no end of controversy among the courts as to its true meaning. One line of decisions holds that it applied only to those cases where the manufactured product is produced by a secret formula or process, while the other list of cases assumes that this feature is merely accidental in the decision and that the case is ample authority for contending that a simple effort to uphold prices on the part of the manufacturer is not an evidence of undue restraint of trade in itself.

In a New York case, there can be no doubt but that the validity of a resale agreement was assumed by the court. In this case the retail dealer failed to live up to his agreement to resell the manufactured produce at a certain price, under penalty of having his supply cut off by the manufacturer. When the manufacturer did, in fact, so shut off the supply of goods, the dealer brought an action for damages. The court, however, held that no action for damages could lie under a contract where the dealer had not first performed his portion of the agreement.

In this connection it might be noted that this is a sound doctrine of contract law and in an action for damages is generally what might be termed a condition precedent to the right to maintain an action. But in a case where the contract is illegal from its inception or impossible of performance, or contrary to public policy, the other party may find relief by setting up or establishing these facts at the time prayer is made for relief.

In a case decided in 1901, the court adopted the flat view that where a retail dealer has failed to live up to the terms of his agreement to maintain prices, he cannot have the contract set aside as being in restraint of trade. The contract stipulated that the wholesalers and jobbers were not only to agree to charge the retailer a fixed price for the product, but that they were also to secure contracts from the retailers whom they supplied in which the latter agreed not to resell to the consumer for less than a stipulated price. The ground upon which the court based its decision was that a manufacturer of a product has the right to determine himself whether he will sell his product or not, and to whom, and in selling they have the right to impose such conditions as they see fit. It would be a far cry to say that such was the opinion of the courts today, because they have trimmed their sails considerably in the last 18 years, but it is not saying too much to state that even this decision, as sweeping as it seems to us today, is at least partly correct.

A Leading Case

A New York case, generally looked upon as a leading case on the subject of the validity of such contracts, especially as they involved the sale of goods under the rebate plan, is worth noting. In this case the court said:

It is true that it does away with the competition among dealers as to prices, but it creates no restrictions upon them as to the quantities which they may be able to sell, or the territory within which they may confine their transactions; but upon the question of prices we must bear in mind that the goods are covered by patent rights and trade-marks which give the proprietors the exclusive rights at specifying the prices at which the articles shall be sold and, following this, the right also to require dealers to maintain the prices specified. The plan does not operate to restrict sales in any locality, but contemplates a ready method of distributing the goods throughout the country. It is, in effect, the creating of an agency on the part of the proprietors by

which every druggist throughout the United States may receive the goods and dispose of them as agent of the principal, upon receiving the commissions agreed upon therefor.

While this decision involved an article that had been patented and which undoubtedly conveyed a right not found in every manufactured product, it is not cited here to bring out that point. The value of that decision in the present instance is to bring out the idea which the court advanced as to the contract fixing resale prices which established in effect, a series of agencies, rather than a series or mere sales.

If the agency theory is possible of application, there can be little doubt as to the fact that the manufacturer has a right to follow his product to the ultimate consumer and exercise every measure of control over it, as to price, distribution and the other ordinary conditions upon which it may be sold, regardless of whether such manufactured product is patented or the result of a secret process or not.

For where the sale is made under an agency agreement or a quasi-agency agreement, the goods have not yet passed from the ownership of the manufacturer and do not so pass until every condition which he has outlined as to their disposition has been fulfilled. As owner, he has a legal right to prescribe any and all conditions as to their sale that he may desire, such being one of the recognized rights of legal ownership.

But it is not always possible to urge the agency theory for the reason that many courts take the opinion, and indeed, it is coming to be more and more confirmed in the later decisions, that the contract fixing resale prices does not establish in any measure an agency agreement, but that it is merely an incident to the sales agreement, and that once the sale has been made that the wholesaler or jobber or retailer, as the case might be, has acquired absolute ownership in the manufactured product and may do as he pleases with the product. Indeed, this theory has even been applied in the later decisions to the case of patented manufactured products, as we shall presently see; the courts holding that the manufacturer can make his agreement or restriction as to price binding only upon one party, the person to whom he sells and that he cannot thereby bind sub-purchasers.

The "Cut-Rate" Plan

Judge Lurton, afterward a member of the United States Supreme Court, speaking in a decision rendered while on the Circuit Court of Appeals, rendered a decision adverse to the validity of contracts entered into for the purpose of maintaining prices. He said:

> The general averment that, under the "cut-rate" plan of doing business, demoralization and damage resulted, while, under the "contract system," enlarged sales and increased emoulments have and will follow, does not answer the question as to why such covenants are necessary to protect complainant against consequences which may fairly require protection. Looking to the averments of the bill as a whole, and to the scheme of the business as disclosed by the contracts themselves, we cannot escape the conclusion that the covenants restricting sales and resales have as their prime object the suppression of competition between those who buy to sell again. Any benefit to the retained business to result from them is manifestly but an incident to the main purpose, which is to benefit his vendees and subvendees by breaking down their competition with each other. Restraints which might be upheld if ancillary to some principal contract cannot be enforced if, when unmasked, they appear to be the main purpose of the contract, and not subordinate. The covenants in the contracts signed by the retailers are not even collateral to any sales by the complainant, but to sales made by the wholesalers. Although they run to the complainant, their prime purpose is neither the protection of the retained business of the complainant, nor of the wholesaler, but only to prevent competition between the retailers.
>
> Covenants protecting the seller of property against the competition of the buyer, by its use against the business retained by the seller, which are upheld if not wider than necessary for that purpose, have been covenants where the main purpose has been to protect the seller himself against competition directed against his retained business.
>
> No instance has been called to our attention where the main purpose and principle, if not only result, is to protect buyers against the competition of each other. If such a principle shall find lodgement in the law, it must be upon economic reasons which are now in conflict with those which now prevail.
>
> The single direct effect of the "system of contracts" is to limit and restrain the right of each wholesaler and each retailer to transact business in the ordinary way. Each obtains a price enhanced by the "system" over the "cut-rate" or "cut-price" method which has before prevailed, and which it was the object of the new plan to abolish. It may be that sales went on as before, but at a higher price to the consumer than would otherwise have been paid.

Secret and Special Processes

Manufacturers of goods produced by secret process have not been slow in attempting to urge upon the courts the theory that they should enjoy the same protection accorded those who manufacture goods under patents or copyrights. They contend that if the one enjoys a monopoly established by law, that the owner of a secret process should also be protected in his formula by the law.

This theory has been accepted by a number of courts, and it has been rejected in others. The rejection by some of the courts, it seems, depended more upon a failure of the manufacturers to clearly distinguish between the need for protection in the secret formula and in the need for protection of the goods produced by such formula.

There is no doubt but that the manufacturer having a secret process has some protection at common law against the discovery of his process and will be allowed to take such measures consistent with public policy that he deems necessary to afford himself the proper measure of protection in his secret. But the law has been loath to extend the mantle of protection also over the results of his secret process and thereby create a virtual monopoly for him in the thing produced. As to the definite conclusions to be gained in specific instances only an examination of the decisions as they are apt to apply to a given business, will suffice.

In a given case, one judge said:

> It is alleged that the complainant is the exclusive owner of these secret formulas, and the exclusive manufacturer of these remedies. It follows that, until voluntary disclosure or lawful discovery, the complainant has an exclusive property in these trade secrets, and has the exclusive right to make, use and vend the articles made thereunder. The exclusive right of property in a trade secret is, of necessity, a monopoly; the same as a patent or a copyright. The complainant may make these articles or refrain from making them. It may sell them, or refrain from selling them. It may sell them to one person and not to another, and at such prices and upon such conditions as it may deem most advantageous. Contracts like those set out in the bill, concerning articles made under trade secrets, the same as similar contracts made concerning articles made under a patent or a copyright, are outside of the rule of restraint

of trade, whether at common law or under the Federal statute.

It will be noticed that the principal right guaranteed in this decision goes rather to the property in the secret process and to the right to protect it, than to the property in the articles produced by the secret process. While it may appear at times to be beside the question to urge a distinction in this respect, the fact remains that there is such a distinction and that it has, in other instances, played a very dominant part in the decisions of the courts. The true test, in the mind of the manufacturer, at least, of the legality of his trade contracts fixing resale prices should ever look to this fact.

It has been brought out in certain cases that the monopoly sought in goods produced by secret processes pertained to the result of the secret formula and not to the formula itself. Furthermore, when a producer elects to make and sell a product according to his own formula, he effects the public interest if he attempts to restrain trade once his product has passed under the dominion of the buyer. And for economic reasons the tendency seems to give no more protection to those using secret processes in respect to the results of such process, than to those who produce their goods in simple and ordinary ways.

The next and last article of this series gives some recent decisions, and the summary.

Use of Microscopes in the Gage Section, Bureau of Standards

By R. L. RANKIN

Assistant Physicist, Bureau of Standards

The progressive tool and gage maker should find in this article from the Bureau of Standards suggestions as to the use of the micrometer microscope in checking the accuracy of precision instruments. The author concludes warnings against careless handling and cleaning of the microscopes and points out the ease with which inaccuracies may result from such treatment.

MANY machinists and toolmakers, who before the war used microscopes only for locating the center of work in the lathe, have found them very useful recently in checking up the dimensions of completed or partly completed work. The Gage Section of the Bureau of Standards receives certain types of gages, mostly profile gages, which can be inspected most readily and accurately by the use of microscopes. We shall discuss the use of microscopes alone or in connection with precision blocks, without reference to the importance of their function as integral parts of various types of measuring machines.

Fig. 2 shows one of the most common uses of a microscope and precision blocks in the inspection of a profile gage. In this type of gage, the dimension to be measured is distance from the left-hand edge of the gage to one of the limit lines near the other end.

Two parallel bars are first clamped at right angles to each other at one corner of a surface plate, and the gage is set between them. The right-hand parallel bar must be clamped firmly and the gage should be placed squarely against it. One side of the base of the microscope stand is machined off so that it too can be brought up firmly against the right-hand parallel bar. After this is done, the microscope is moved, without changing the position of the stand, until the etched line on the gage from which the measurement is to begin can be seen through the microscope.

The movable cross-hair of the microscope is set right on this line, and we have the zero setting. The microscope is shown at the zero position in Fig. 1. Precision blocks are then inserted between the parallel bar and the machined side of the microscope base, as shown in Fig. 2, until the left-hand edge of the gage (to which the measurement is to be made) appears in the field of the microscope. Unless the cross-hair happens to come right on the edge of the gage, the microscope micrometer must be used to bring it there. The distance between the line and the edge on which the two microscope settings were made is then obtained by adding to the value of the precision blocks the distance through which the cross-hair was moved, as indicated by the microscope micrometer. If more precision blocks were inserted than were necessary to bring the cross-hair exactly over the left-hand edge of the gage, the distance measured by the micrometer must, of course, be subtracted from the value of the blocks. In order to measure distances with the micrometer, the micrometer screw must be calibrated. If the microscope has only a fixed cross-hair, this can be brought into the correct position, though with more difficulty, by trying different combinations of precision blocks.

When a small measurement, such as the distance between the two limit lines, is required, it can be made directly by means of an eyepiece micrometer. The dis-

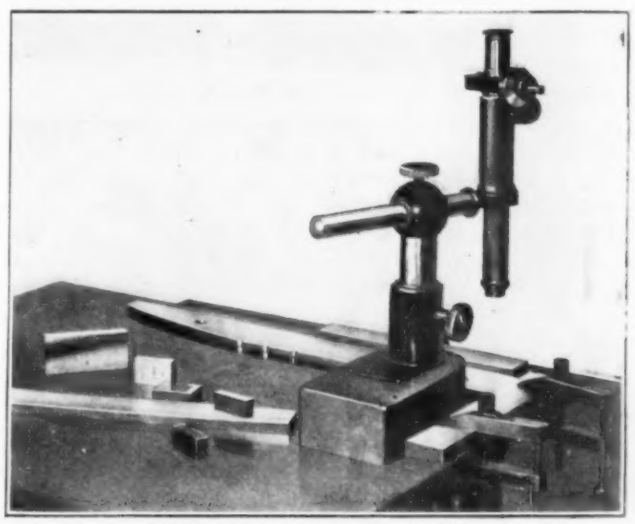


FIG. 1. PRELIMINARY SET-UP FOR CHECKING PROFILE GAGE

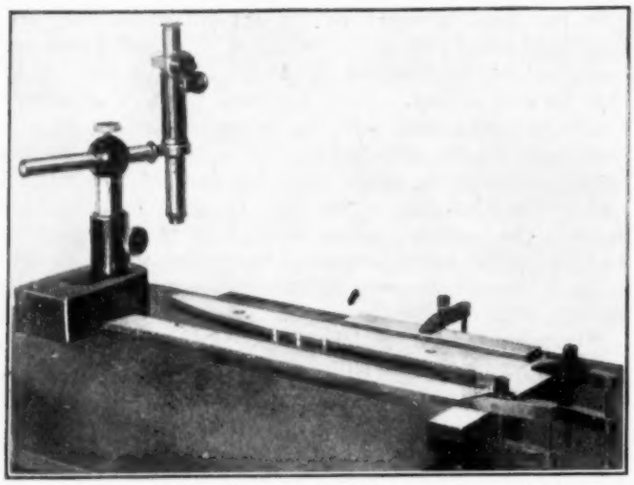


FIG. 2. GAGE BLOCKS IN POSITION BETWEEN MICROSCOPE AND PARALLEL

tance which can be measured by this method depends upon the microscope used, but with a low-power microscope, such as is best for gage inspection, measurements of about ¼ in. usually can be made with the microscope micrometer alone.

A similar use of the microscope is for the determination of the height of a line on a gage, as shown in Fig. 3. It is frequently more convenient to set the gage in an upright position for inspection, as shown in this figure, rather than to lay it down flat as was done in the case described above. The microscope is focussed on the etched line of the gage so that by looking through it a scriber can be set in the middle of the line. The distance of this line from the base of the gage is simply the total value of the blocks used in bringing the scriber up to the middle of the line.

Microscopes that are satisfactory for inspection work can be purchased from any good optical manufacturing company. The microscope and stand shown in the photographs were bought from the William Gaertner Co., Chicago, and the base of the stand was machined off flat and square on the bottom and on several faces in the Gage Section shop. A complete stand could be made in almost any shop without a great deal of difficulty. A 48-mm. or 2-in. objective gives all the magnification that is desirable for most of this work, but it is convenient at times to change the objective. When doing this, one should have an elementary understanding of microscopes and, particularly, of micrometer microscopes.

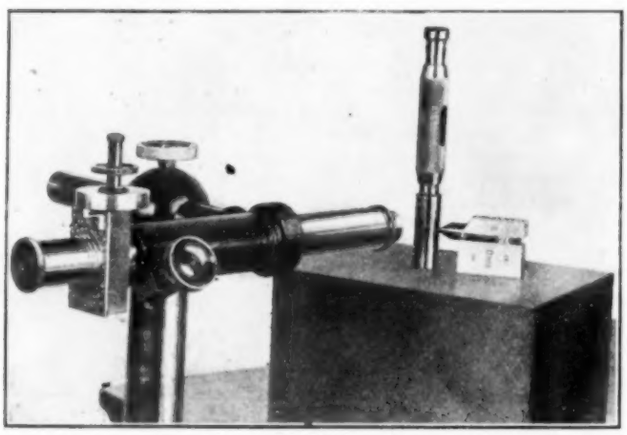


FIG. 3. CHECKING A PLUG GAGE BY MICROSCOPE

Compound microscopes, such as are commonly used in laboratories for higher magnification, must have at least two lenses. The lower lens or system of lenses which forms real, enlarged images of the object, is called the objective. The lens nearest the eye, called the ocular or eyepiece, magnifies the images formed by the objective. The amount of magnification of a microscope depends upon the focal lengths of the objective and of the eyepiece, and upon the length of the main tube.

Objectives are designated according to their focal lengths as 8, 16, 32, 48 mm., 1 in., 2 in., etc. The smaller the focal length of an objective, the greater the magnification and the nearer to the object the microscope must be brought to get it in focus. Eyepieces are not commonly designated by their focal lengths, as objectives are. Cross-hairs often are mounted in the eyepiece. Sometimes they consist of finely cut lines on a glass plate but in many cases they are pieces of spider web stretched across a brass frame. One should be careful when removing an eyepiece not to break these spider lines.

Particular care must be exercised not to disturb the optical parts of a microscope that is provided with an eyepiece micrometer for making measurements. In such microscopes, a small scale is etched on a round piece of glass in the eyepiece. This micrometer scale is used usually in connection with a movable cross-hair attached to a micrometer screw. In such cases, the scale simply indicates the number of revolutions made by the micrometer head, and a row of little teeth, called the comb or counter, may be used instead. The value of the graduations on the micrometer head must be determined separately for each instrument. Even then these values will not remain true unless the microscope is kept in the same adjustment. If we change the objective for one of less focal length, the scale value is reduced. The operator should exercise great care not to allow one tube to slip within the other when an adjustment is provided for changing the tube length of a micrometer microscope. This will destroy the value of the micrometer calibration as surely as changing the objective, and the change is less likely to be noticed. It is best that a person not fully familiar with microscopes should not attempt to clean them at all. Some elementary "Reminders Regarding Microscopes" will be sent upon request to the Gage Section, Bureau of Standards, for a copy of Communication B511.

A Highly Trained Executive

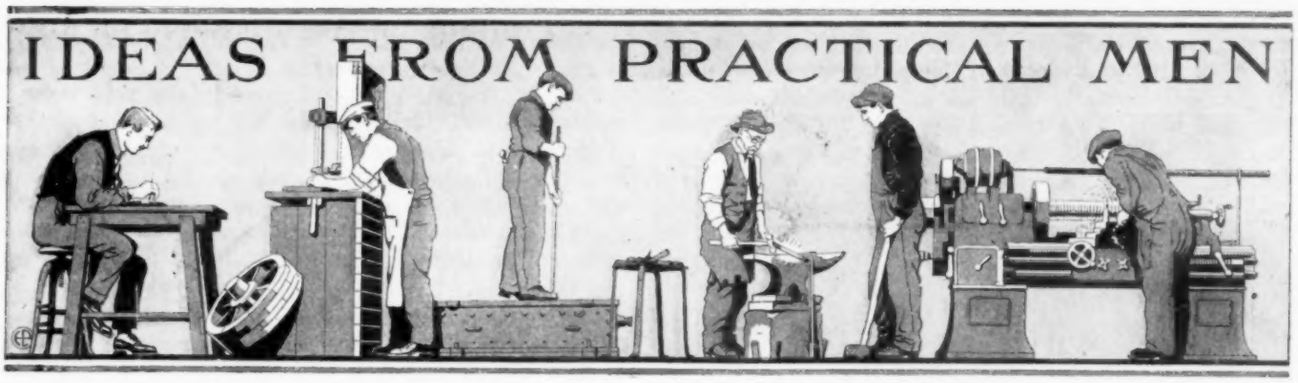
Dear Mr. Editor:

In a recent management article I noted the statement that a man had succeeded in the truly remarkable feat of reducing production costs 100 per cent.

It would seem to me to be a tremendous advantage if this man could be engaged by the Government and put in charge of the production of foodstuffs and other necessaries of life. By the exercise of his inimitable talent in this direction old High Cost of Living, as well as the high cost of most everything else, would be reduced to bearable proportions at one fell swoop.

After having gotten this detail into shape so that his subordinates can keep the machinery moving, I suggest that he be elected to a high political office where he would have full opportunity to effect a similar readjustment in the matter of taxes.

HARRY SENIOR.



Boring With an Improvised Rig

By M. E. Hoag

Some unusual jobs are handled in the shops of the Jones Foundry and Machine Co. of Chicago. The limited number of pieces in many of these special jobs does not warrant the making of special and expensive jigs or fixtures, so other simple but accurate means of accomplishing the desired results must be devised.

The piece shown in Fig. 1 consists of an iron casting

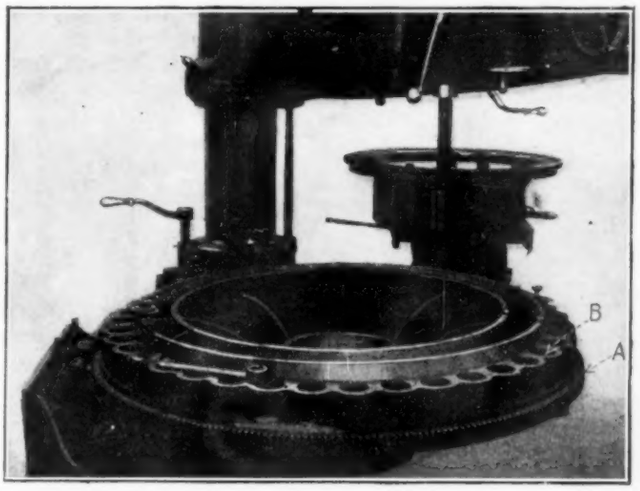


FIG. 1. THE WORK TO BE BORED

to which is shrunk a bronze gear ring *A*. The only work done on these pieces as they came to the machine shop was the shrinking on and rough-turning of these bronze gear rings.

The first operation on these pieces was truing up, turning and boring on a vertical boring machine, one side being as shown in Fig. 1, and the other side having a hub about 2 in. long and 14 in. in diameter turned and faced. The next operation was hobbing the 285-tooth 5-pitch gear in a Jones superior gear-hobbing machine. These operations are all of an ordinary nature but are mentioned because they lead up to and have an importanat bearing on the real job which consists in accurately locating and boring the 40 holes through both top and bottom sides of the cored rim as shown at *B*. The rig for indexing and boring these holes is shown in Fig. 1, close-up views of the worm-indexing head, and the fixture used for supporting the boring tools are shcwn in Figs. 2 and 3 respectively.

A 5-pitch worm *A*, Fig. 2, was made and mounted on the angle plate *B*, with small bearings set close to the ends of the worm to prevent end play. The collar *C* was graduated in eight equal divisions and attached to the wormshaft *D* by a setscrew. A casting was faced and bored to receive the hub on the under side of the piece to be machined and was bolted firmly to the bed of the radial drilling machine. After lowering the piece into position in this casting the angle plate was adjusted until the worm had the proper bearing in the gear. The first hole to be bored was carefully laid out and proper location made under the drill spindle as shown in Fig. 3. The setscrew in the collar *C*, Fig.

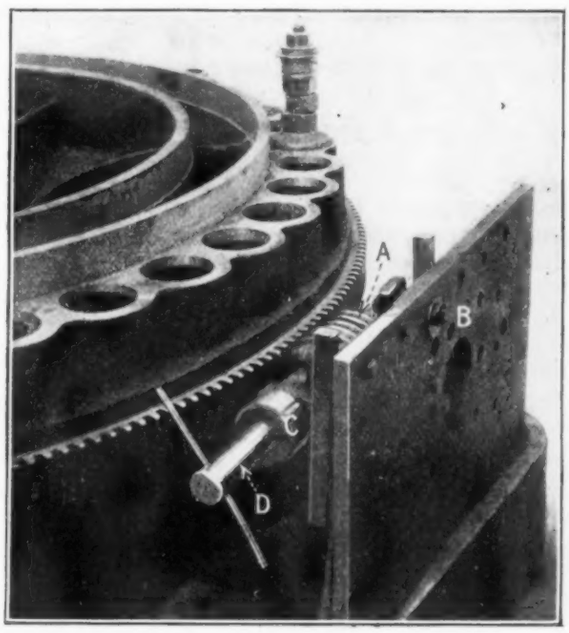


FIG. 2. THE METHOD OF INDEXING

2, was loosened and the collar turned until one of the graduations matched up with a zero mark on one of the worm bearings. After this first set-up and adjustment seven and one-eighth turns of the worm correctly indexed the piece for the next hole, and so on until all forty had been bored. A check was kept on the work by use of the adjustable double-plug gage shown at *A*, Fig. 3, the plugs of which were first set to correct distance by use of Johansson gages.

Owing to the fact that the 40 holes were cored in the casting it was necessary to furnish a very rigid support for the boring tool, for otherwise the irregularity of the holes would cause it to run out of true. This supporting was done by clamping to the auxiliary table of the drilling machine the jig shown at *B*, which was a very accurate one used for boring housings for spur-

gear reducers on which work a long bushing *C* was used. This bushing was lowered until it was very close to the casting and was then clamped firmly in position

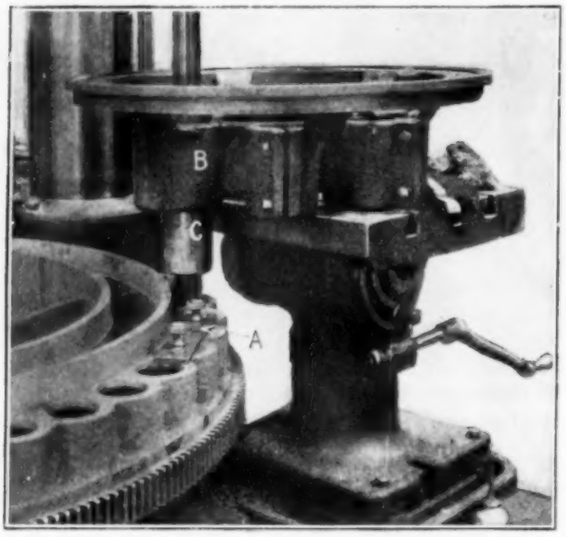


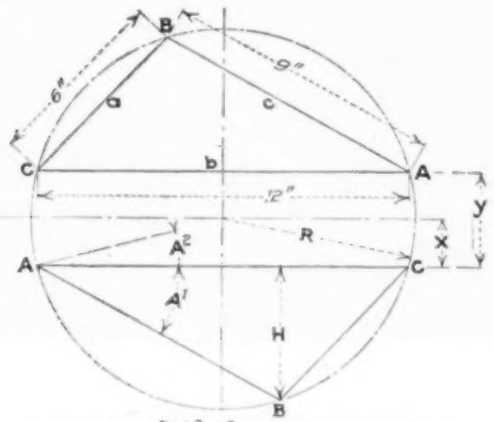
FIG. 3. THE JIG AND THE GAGE

thus furnishing very rigid support for the boring tool and drill spindle. Suitable jacks and bolts were provided for supporting the casting while boring.

Finding a Center by Trigonometry

BY J. MOORE

Points *A*, *B* and *C*, shown in the sketch, represent holes to be bored and the requirements were that the centers of two such sets of holes were to fall upon



$\text{COSINE-}A = \frac{c^2+b^2-a^2}{2 \times c \times b} = 0.87500 = 28°57'20''$

$\text{SINE } A^1 \times C = H = 4.3571$

$\frac{b}{2} \times H = \text{AREA} = 26.14302$

$\frac{a \times b \times c}{2 \times \text{AREA}} = 2R = 12.3934 \quad R = 6.1967$

$\frac{b}{2} \div R = \text{COSINE } A^2 = 14°28'30''$

$R \times \text{SINE } A^2 = X = 1.54886$

THE LAYOUT

the circumference of a circle struck from a common center to be located from the three known points. The dimensions *AB*, *BC* and *CA* were available and the center was determined by using the accompanying formula. When the holes were buttoned and bored in the usual manner the error for the entire circle was found to be less than 30 seconds of arc.

Forming an Accurate Ball on the End of a Rod

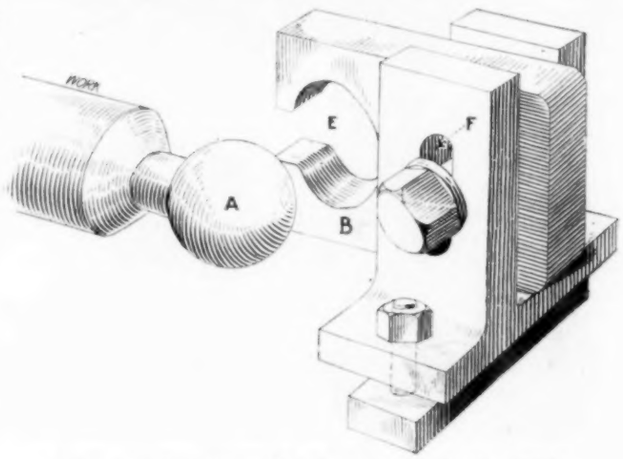
BY E. A. DIXIE

The article on the above subject on page 1141, Vol. 50, interests me because I have done a great deal of ball turning, from turning ivory billiard balls with hand tools, to finishing them entirely by machine.

Bernie Soule's statement of the theory of ball turning is correct, but his practice is at fault. I have yet to see a really smooth job come from a fly cutter, and no one would call a ball accurate which did not have a smooth surface.

For one ball, or at most, a few balls on the ends of rods, the fly cutter is a satisfactory method of forming, but where quantities are required and where a very fine smooth surface is necessary, the following method will be found quick and by its use balls can be formed which will not vary one from the other by more than one or two "tenths." By this method the balls can be formed on the ends of the rods without having a center, also without leaving either a flat or a tit on the end surface of the ball, either of which is a necessary result of the fly-cutter operation.

The stock is gripped in the lathe chuck in the usual manner and the ball rough-turned, say, 0.005 in. or so



THE WORK AND THE BALL-FINISHING TOOL

over size. This is done with a formed tool held in the cross-slide of the lathe or turret lathe, whichever is used. The rod is now cut off to the desired length and the same operation repeated till all the blanks are rough-turned. Balls $\frac{3}{4}$ in. in diameter made in this manner will vary in size considerably, but all the operator has to beware of is making the balls too small.

The final finishing operation can be done either in an engine lathe or turret lathe with the tool shown in the illustration.

The work as it comes from the roughing operation is shown at *A*. At *B* is the finishing tool. This is made of a piece of flat tool steel, and for balls up to $1\frac{1}{2}$ in. in diameter should be about $\frac{5}{16}$ in. thick. The other dimensions depend to a certain extent on the dimensions of the lathe used so they are not given.

The hole *E* is bored small enough to allow grinding to the finished size of the ball after hardening; that is to say, if the job of ball turning is a very particular one. The elongated hole *F* depends on the size of the bolt to be used. It must be enough larger than

the bolt to allow the tool to float $\frac{1}{16}$ in. up and down and sidewise.

After hardening and grinding out the hole *E* the flat cutting surface is ground preferably on a surface grinding machine which leaves the edges of the hole *E* on the cutting side of the tool a sharp right angle.

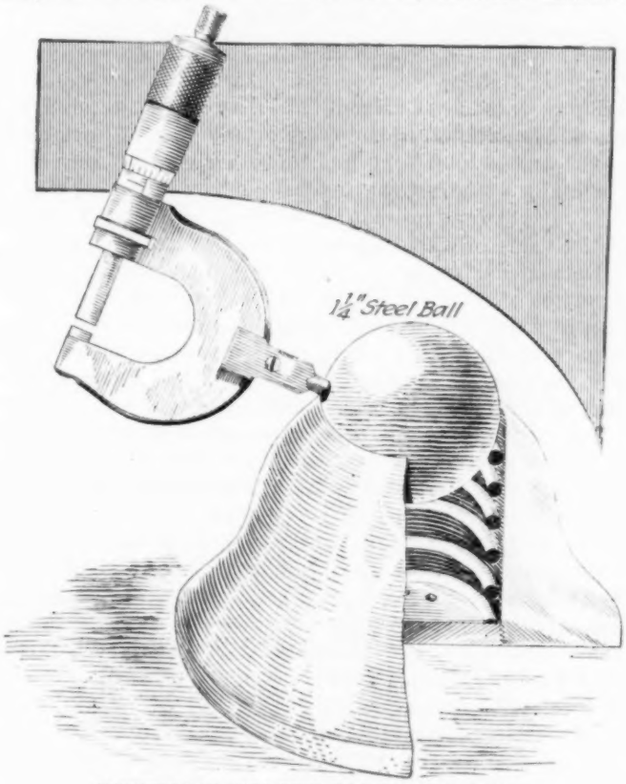
The tool is mounted in a bracket which is held in the tool slide of the lathe. When an engine lathe is used, I prefer to set the compound rest parallel with the ways of the lathe.

In operation, the center of the hole *E* is brought approximately in line, crosswise of the lathe, with the center of the rough-turned ball *A*. The crossfeed is now used to move the tool toward the work. As the tool is free to float either up or down or endwise, it does not matter whether the ball *A* runs true or not as the tool will rise and fall with it. If the ball is steel it should be well oiled, preferably with lard oil during the turning operation. The tool is fed clear past the ball. The square edges of the tool scrape off the few thousandths left for finish very quickly, and when the ball is small enough to enter the cutting side of the tool, the cutting ceases and it is not reduced further in size. The writer remembers a very particular job of ball turning which was done in this way. There were 200 soft-steel balls $\frac{3}{4}$ in. in diameter with $\frac{5}{16}$-in. stems, 4 in. long. The balls were made on a screw machine to 0.005 to 0.010 in. oversize, the greatest difference in size from the largest to the smallest, after finishing with the tool here described, was 0.0002 in. as near as we could measure.

A Universal Micrometer Stand

BY R. J. KIRWIN

A handy stand for holding a micrometer on the bench in position for use is shown in the illustration. It may all be made from scraps of any suitable material



UNIVERSAL HOLDER FOR MICROMETER

except the ball, for which a standard steel ball about 1¼ in. in diameter should be used.

A hole slightly larger in diameter than the ball is bored nearly through the base from the under side, leaving a shoulder at the top so that the ball may not pass clear through. This may be done roughly with two drills, but if one desires to be particular a much better job may be done by chucking the base and boring the hole, when it will be an easy matter to fit the shoulder to conform to the contour of the ball.

The other end of the hole is to be threaded three or four turns to take a plug to hold the spring under tension. The plug may be made of heavy sheet metal by sweating a piece of the material to a block and holding the latter in the lathe chuck while turning and threading it. A couple of small holes should be drilled in the plug to permit the use of a temporary spanner for setting it into place.

The ball is annealed and a hole drilled diametrically through it to take the shank of the small clamp that holds the micrometer frame. A special shouldered screw in the clamp serves to tighten it.

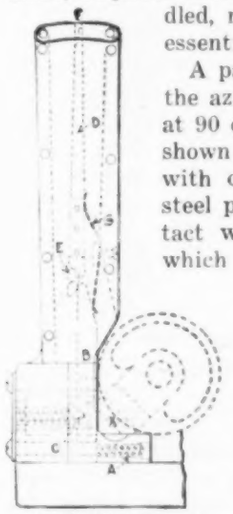
The spring should be of sufficient tension to hold the micrometer firmly in any desired position without being so stiff as to render it difficult to move. This will probably necessitate some experimenting to get it just right, and it will be worth while to take the trouble to close down the top coil of wire so as to make it stand square with the axis of the spring, and tool out the ring so formed to fit the ball.

This device will hold the micrometer in almost any desired position, and it may be moved without loosening the clamping screws. The base should be heavy enough to resist the pressure necessary to shift the position of the micrometer.

A Square With Multiplying Levers

BY FRANK C. HUDSON

The making of gun sights involves extremely accurate work and demands inspection instruments which must be equally accurate. Production, on the other hand, requires instruments which can be quickly handled, making speed and accuracy both an essential part of the design.



"MEASURING A SQUARE CORNER"

A part of the sight is a steel shank on the azimuth base, which has two surfaces at 90 deg. to each other. One of these is shown in position at *X* in the illustration, with one side resting on the hardened-steel plate *A*, the other side making contact with the lower end of the arm *B* which is pivoted on the knife-edge at *C*. The upper end of this arm rests on the short end of *D*, this being pivoted at *E*, and giving great multiplication on the scale *F*. The flat spring *S* keeps the lever end in contact and prevents backlash. The knife-edge bearing *C* is spring mounted to prevent injury from excess pressures. If the steel shank is square, it simply holds the lever *B* square when pressed against it. But if it is not square, it rocks the lever *B* either one way or the other and shows wether it is more or less than 90 degrees.

EDITORIALS

Is Your Credit Good?

MODERN business could not exist without "credit," as we call the system which permits a man to get the use of capital or goods without paying for them at once. This use of the term is in a purely financial sense but there are other forms of credit equally necessary to the successful operation of an industry.

The employer who has always been absolutely square with his men, has treated them as fellow-workers and not as slaves, and has always been accessible to any man with a real grievance will find that he has a credit balance with them in trust and good-will that will be more valuable than any amount of insurance when hard times come.

Likewise, the worker who makes it a point to stick to his job and do it to the best of his ability, to meet his employer half-way when differences are to be settled and in general to do perhaps a little more than is absolutely necessary to hold his job is laying up a store of credit that will stand him in good stead when a promotion is to be made or a reduction in force results from business depression.

Credit of any sort is not an over-night mushroom growth. Based on confidence it must be built up gradually, each trust-compelling act adding its bit to the structure. The unfortunate part of it all is that just one little slip will bring the whole edifice crashing to earth like an airplane with fouled controls. And like the wrecked plane, although new parts may be substituted for the broken ones and the rebuilt machine may not be told from the original, it will never be given the same trust by the experienced pilot.

Reliable statistics show the percentage of failures of manufacturing concerns to be disturbingly high. While lack of business ability is undoubtedly the principal cause of failure, it is equally sure that a liberal supply of the kind of credit we have been discussing would have saved some of them from the rocks of bankruptcy and put their business as a whole that much ahead.

In these times anything that can be purchased without the use of money looks pretty good to most of us. Here we have something that can be bought for nothing and which, at the same time, money cannot buy. Doesn't it look like a good investment?

Coöperative Quality Maintenance

ONE of the brightest examples of concerted and cooperative effort to maintain the quality of a product is represented by the certification system of the American Malleable Castings Association. This organization is doing something that has perhaps never been attempted by a similar industrial organization, its members getting together in order to improve the quality of malleable castings produced by them. In this movement, the strong are assisting the weak.

A prominent part of the mechanism of this society is the research department which is maintained for investigations and experiments and for the testing and analysis of the daily output of each member of the association. This research department comprises a laboratory where impartial tests are made upon the product of various member plants—the results of these tests, together with direction for improvement when needed, being forwarded to the member concerned. When a member's product has daily met the requirements of the prescribed standard for a period of three months, a "certificate of quality" will be issued to that member, who may designate his output as "certified malleable castings." These certificates will be renewed quarterly where the quality is maintained.

There have been quality associations formed in the past—some of them for a purely commercial purpose, capitalizing the prestige of its members and with the attempt not to *improve* quality but to *prove* it by the *ipso facto* of membership. Contrasted with this is the American Malleable Castings Association in which membership does not entitle one to claim quality but enables one to prove it.

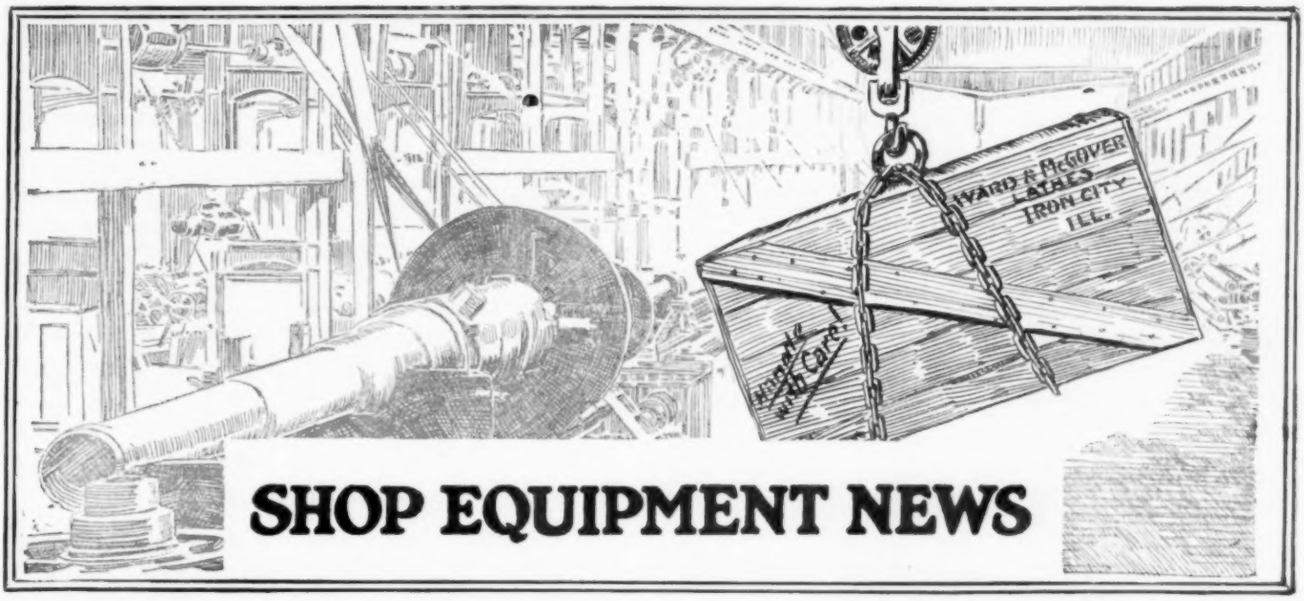
The Caldwell Bill Discussion

THE discussion which preceded the passage on Sept. 5 by the House of the Caldwell Bill HR 3143, providing for the sale of the Government surplus machine tools to educational institutions, was not occasioned by any objection to the measure as a whole. Representative Gard, of Ohio, objected to the payment of the cost of distributing the tools. It was his opinion that, in view of the very low charge which was being made for this property, the schools purchasing the equipment should pay such transportation charges as would accrue. His amendment was carried 26 to 13.

Representative Caldwell, of New York, offered an amendment changing the basis of sale from 10 per cent. of the cost price of the tool to 10 per cent. of its value. He finally withdrew that amendment on being convinced that cumbersome precedure would be necessary to arrive at the value of a tool, particularly if it has been used.

Representative Bee, of Texas, is responsible for the insertion in the bill of the clause "upon their application in writing." He asked that this safeguard be made a part of the bill so that no distribution would take place without an application, which would be an indication of a real need for the material.

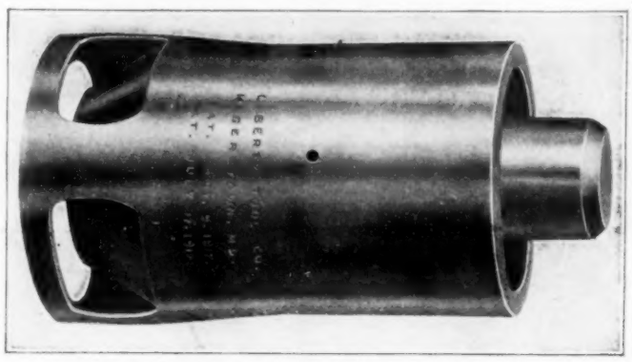
Inquiries already are being received in considerable numbers at the machine-tool section of the Surplus Property Division of the War Department, concerning the supplies which may become available if the bill, which was first proposed by the *American Machinist*, becomes a law. Pending a special scanning of inventories, however, no estimate is being ventured on the kinds or amounts of tools which would be available for distribution to schools. It was stated at the machine-tool section that the sale of surplus property will continue as heretofore. The prospect of the bill becoming a law in the near future will not cause the withholding from general sale any property which might come within the purview of the legislation.



SHOP EQUIPMENT NEWS

Liberty Stay-Bolt Heading Attachment

The stay-bolt heading attachment shown in the illustration is being manufactured by the Liberty Tool Co., Munsey Building, Baltimore, Md., for use in railway and boiler shops for riveting stay bolts, stay rods,



THE LIBERTY STAY-BOLT HEADING ATTACHMENT

or countersunk rivets on all steam, oil or water-tight work. This attachment, which fits on a standard air gun, is used for driving these parts for the service mentioned. The tool may be applied to any make of riveting hammer without making any change in the hammer.

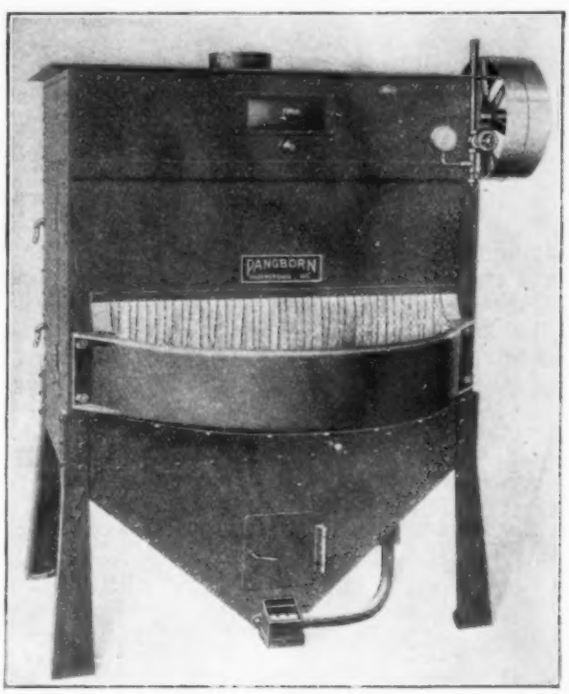
Pangborn Sandblast Machine

The machine shown is made by the Pangborn Corporation, Hagerstown, Maryland.

It consists of a rotating table half exposed, and half in a dust-tight housing in which the blasting action takes place. Work to be cleaned is loaded, turned as required, removed and renewed while the machine is in operation. The table top is 42 in. in diameter and the entire device requires a floor space of but 4 ft. 8 in. by 4 ft. 3 inches.

The sandblast action is of the suction type, the spent abrasive falling through the grated top of the table and returning to the blasting member in a continuous cycle.

The blast projector takes air nozzles interchangeably from $\frac{1}{8}$- to $\frac{5}{16}$-in. diameter, and at 80-lb. pressure the air consumption, with the smaller size nozzle, is as low as 21 cu.ft. free air per minute, while the entire power for driving the table is but $1\frac{1}{2}$ hp. This makes the machine adaptable to the smaller shop and also an admirable auxiliary to larger equipment for special uses, or to take care of periodical peak loads.



PANGBORN SANDBLAST MACHINE

The table top is provided with a 4-in. high guard, which acts as a retainer for light work, which otherwise might be dislodged or blown off by air force; and, with a 10-in. opening for passage of the work to and from the blasting zone, it is available also for pieces of some considerable size and weight. This opening through which the pieces pass from the exposed portion to the blasting zone is closed by multiple, sectional, flexible rubber curtains, which retain the flying abrasive

and dust, making it a hygienic machine and available for installation with other machine tools.

The machine will use either sand or metal abrasive. It weighs 1750 lb., and provision is made for connection to an exhaust system for quick removal of dust and disintegrated material.

McCabe 2-in-1 Double-Spindle Lathe with Rapid-Change Feature

Fig. 1 illustrates a rapid-change feature which is being applied to the two-spindle lathes of the J. J. McCabe Lathe and Machinery Corp., 149 Broadway, New York City. The large faceplate of this machine is obviously a somewhat awkward thing to handle and

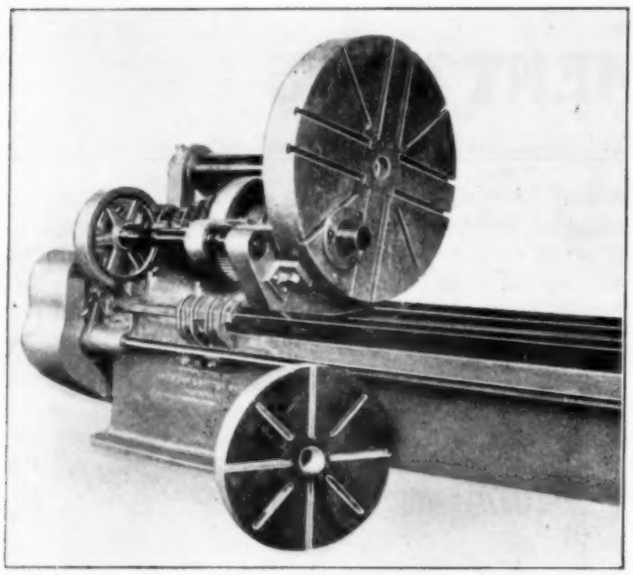


FIG. 1. 2-IN-1 LATHE WITH QUICK-CHANGE ATTACHMENT

changing it under adverse conditions uses up more time than a good shop cares to take on such adjustments. With the new arrangements the large faceplate is put on "for keeps" and locked in position when it is desired to use the small faceplate or a 24-in. chuck. To make the change it is only necessary to remove the internal gear driving pinion from the lower spindle and screw on in its place a steel extension spindle and the chuck or faceplate. A bronze bushing is bolted to the large faceplate as shown and forms a bearing for the spindle extension. A dowel bracket is provided for locating and locking the large faceplate and a wrench for removing the spindle extension.

The latest series of these lathes is being put through with an additional refinement in the form of a three-step cone with double back gears as shown in Fig. 2. With a countershaft speed of 120 r.p.m., this gives nine lower spindle speeds from $6\frac{9}{16}$ to 192 r.p.m., six upper spindle speeds with plain faceplate from 4 to $26\frac{3}{4}$ r.p.m. and six upper spindle speeds with geared faceplate from $1\frac{1}{4}$ to $8\frac{3}{4}$ revolutions per minute.

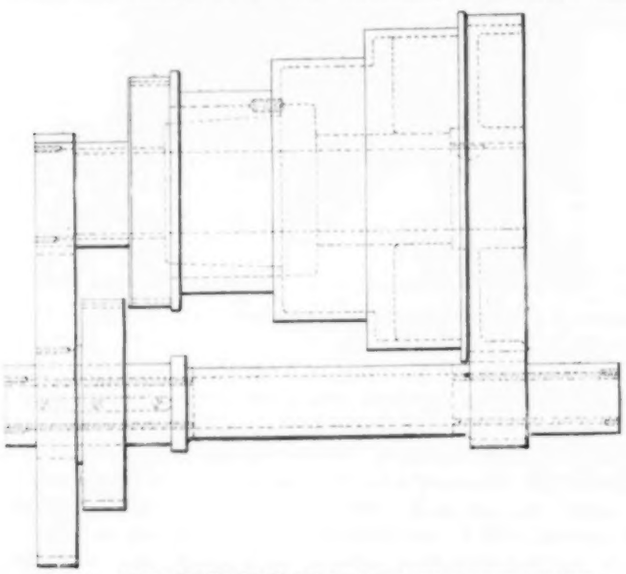


FIG. 2. ARRANGEMENT OF CONE AND BACK GEARS

Nelson 90-Degree and Universal Angle Plates

The Nelson Tool and Machine Co. of Newark, N. J., has recently placed upon the market the two types of angle plates shown in the accompanying illustrations.

The 90-deg. angle plate shown in Fig. 1 is made in four sizes, varying from 3 x $3\frac{1}{2}$ in. up to 14 x 18 in. It is strongly ribbed and provided with a second face parallel to the base. This second face is slotted, as is the 90-deg. face of the plate. The heights of plates of the same size are kept within 1 1000 of an inch limit, as is the spacing of the T-slots. Thus they may be used in pairs for a variety of purposes where parallelism is required.

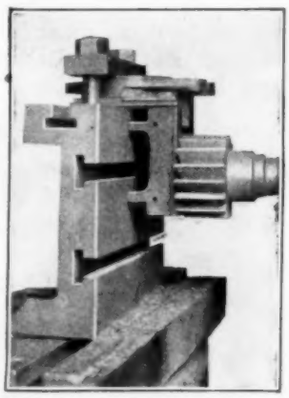


FIG. 1. NELSON 90-DEG. ANGLE PLATE IN USE

Fig. 2 shows the new universal angle plate made by this company. This differs considerably from the small toolmaker's universal angle plate and the regular 6 x 9 universal angle plate formerly produced by the Nelson Tool and Machine Co. The new line covers three sizes: $7\frac{1}{2}$ x 9 in., 10 x 12 in. and 14 x 18 in. A worm and wormwheel provides a vertical swivel adjustment up to

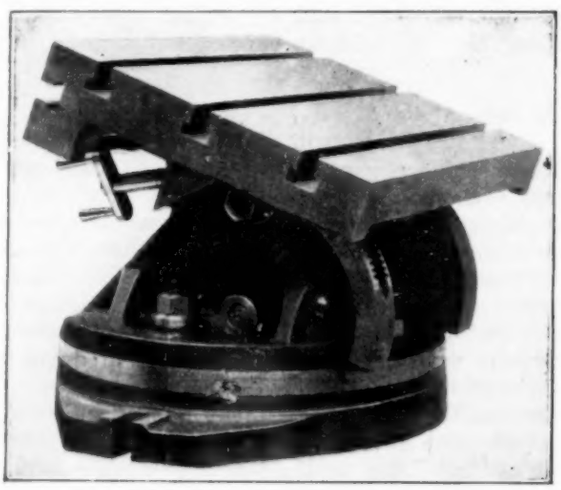


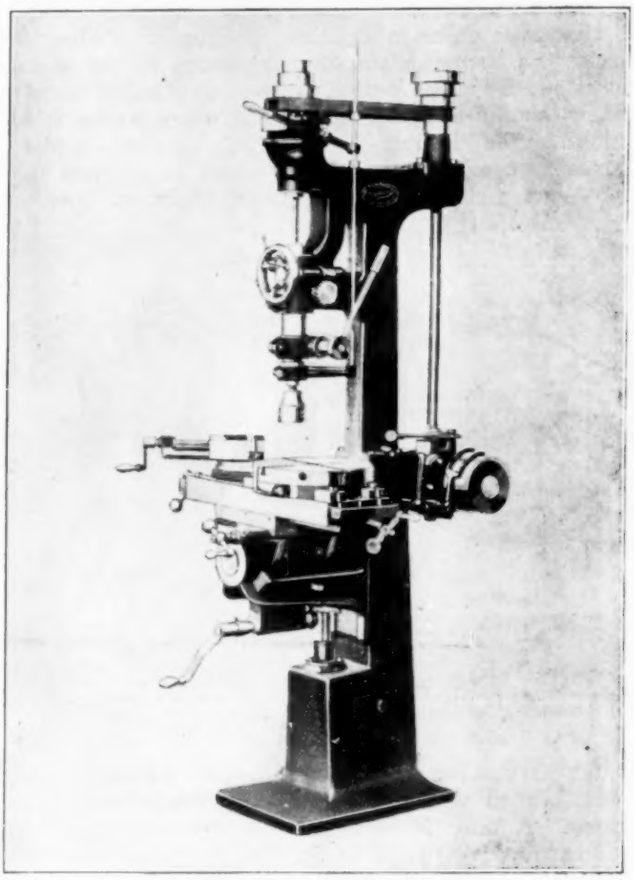
FIG. 2. NELSON UNIVERSAL ANGLE PLATE

90 deg. Vertical locking is accomplished by means of two ¾-in. bolts. The angle plate also swivels horizontally through a complete circle, a graduated collar being included on the base for this purpose. One of the features of the design of these plates is that in no position does the table overhang the base.

A variety of uses will suggest themselves, both for the 90-deg. angle plate and for the universal, in productive departments as well as toolrooms.

Demco Drilling, Tapping and Milling Machine

The Demco Machine Tool Co., 706 Frankfort Ave., N. W., Cleveland, Ohio, has just put on the market the combined drilling, tapping and milling machine shown in the illustration. This machine is known as the No. 40 and differs from the No. 38 drilling and tapping machine in the addition of the milling attachment. The No. 40 machine is built with but one spindle while the No. 38 may be had with from one to four.



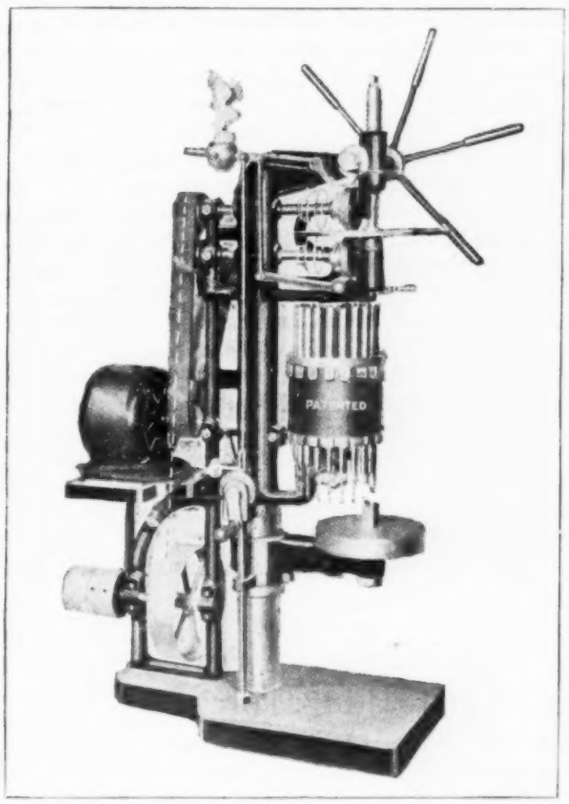
DEMCO COMBINATION DRILLING, TAPPING AND MILLING MACHINE

Diameter of spindle, ⅞ in.; taper hole in lower end of spindle, No. 7 B. & S.; maximum capacity for drilling, ¾ in.; maximum capacity for tapping, ⅝ in.; traverse of spindle, 8 in.; traverse of feed rack, 4 in.; spindle drive cone diameters, 3, 4, 5 and 6 in.; width of belt, 1¼ in.; number of speeds, 18, maximum spindle speeds, 2000; minimum spindle speed, 200; number of open belt speeds, 4; number of back geared speeds, 4; maximum distance spindle to table, 16 in.; minimum distance spindle to table, 0 in.; from column to center of spindle at gap, 8 in.; speed of countershaft, 1000; diameter of drive pulley, 6 in.; working surface of table, 8 in. x 24 in.; longitudinal movement of table, 16 in.; transverse movement of table, 8 in.; vertical movement of table 12 in.; floor space required, 44 in. x 52 in.; height, 6 ft. 4 in.; drill chuck capacity, ⅛ in. to ¾ in.; diameter of circular attachment, 12 in.; vise, length of jaws, 5 in.; depth of jaws, 1⅝ in.; jaws open, 3⅜ in.; weight crated, 1200 lb.

In this machine all controls are brought to the front and the spindle is arranged for quick return. Either sensitive or positive feed is available and positive clutches permit quick changes from right to left rotation. Combination radial and thrust ball bearings take care of side and end thrust and the main spindle bearings are lubricated by a wick oiling system.

Lima Multiple-Spindle Magazine Drilling Machine

The multiple-spindle drilling machine, shown in the illustration and manufactured by the Lima Drill Press Co., Lima, Ohio, is known as the magazine type, and has features not common to multiple drilling machines. This machine will be found useful in the toolroom and to the shop man who has use for a number of various size drills, reamers and countersinks, eliminating the necessity of hunting and changing tools for each different operation.



MULTIPLE-SPINDLE MAGAZINE DRILLING MACHINE

Height, 42 in.; base, 11 x 28 in.; floor space, 14 x 28 in.; diameter of column, 2¾ in.; net weight, 160 lb.; table diameter, 7 in.; vertical movement of table, 8¼ in.; lateral movement of table 12 in.; magazine diameter, 6 in.; magazine length, 5¾ in.; number of spindles in magazine, 16; length of drill and spindle combined, 11½ in.; vertical movement of drill, 2½ in.; drills, ⅛ to ⅞ in.

The magazine having 16 spindles acts as a drill rack for 16 different sizes of tools. Each of these can be quickly brought into position for immediate action by simply turning the magazine to the point where the drill to be used is in alignment with the driving shaft. When a spindle is in the correct position for drilling, the magazine is locked by means of a bar, attached to the machine column which engages one of the slots in the bottom of the magazine.

At the top of the magazine there is provided a convenient combination gage and index showing at a glance

the size of each drill. When a drill is changed, the gage and index are also changed which eliminates all delay and guess work. The drill holders are arranged for straight-shank drills, small split collars being provided for the various sizes. The drills can be removed independently or a drill and spindle together can be lifted out from the top of the magazine. All the drill spindles except the one in position for work are locked in the "up position" and cannot be accidentally forced down. When an operation is completed and the feed wheel is released, the tool is returned to the up position by an internal coil spring which acts similarly on all the spindles. The magazine is automatically unlocked when the friction drive is disengaged, and can be easily turned to right or left when shifting another drill into position for work.

A noteworthy feature is the friction drive which is obtained by means of an aluminum disk 10 in. in diameter and $\frac{1}{4}$ in. thick. The disk is attached to the driving shaft and is driven by means of two leather covered friction wheels, each being $2\frac{1}{2}$ in. in diameter and $\frac{1}{2}$ in. wide. These driving wheels are directly opposite each other, the one above resting against the upper surface of the disk and the one below about $\frac{1}{8}$ in. away from it. When the feed wheel is turned, the lower friction wheel is automatically forced against the under side of the disk, thus causing it to revolve.

The two opposed wheels serve a two-fold purpose by doubling the frictional contact and balancing the thrust.

Speed regulation is automatically obtained for each drill when rotating the magazine into place, as a rack-and-pinion device changes the position of the two friction driving wheels on the disk. When the driving wheels are near the center of the disk, the disk and spindle will obviously travel at maximum speed, and the drills are so arranged in the magazine that the smallest drill is in alignment for use at that time. The machine is suitable for drilling wood as well as metal, and each spindle works in an adjustable bronze bushing arranged to take up lost motion due to wear. The illustration shows the machine arranged for both motor and countershaft drive.

The Liberty Rivet Furnace and Heating Torches

The Liberty Tool Co., Munsey Building, Baltimore, Md., has placed on the market a new self-contained tank and heating torch for use in heavy work in connection with railway and similar shops. The torch, Fig. 1, is operated from the tanks with only one line of hose leading to the burners. Compressed air furnished from an outside source is employed to give the desired pressure of oil in the burner, and the single hose line to the burner makes it more convenient to handle in close places. It is claimed the torch will heat to any desired temperature and can be used out in the open air with excellent results. A feature of the torch is that at its base it is equipped with a coil of pipe which permits the heat of the flame in the cone-shaped burner to preheat the oil before it issues from the burning jet.

The rivet heater, Fig. 2, is portable, and can be moved about very readily, as it is of light construction. The burner itself is located in the body of the furnace which is seen standing on the three-legged pedestal at the left of the illustration, and this is provided with a cast-iron tray which will catch any drippings of

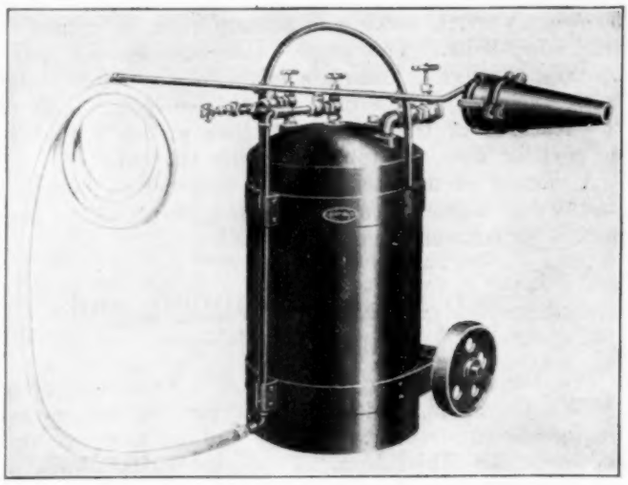


FIG. 1. THE LIBERTY HEATING TORCH

oil that may occur in lighting the burner. When in service the burner is usually surrounded by the metal jacket shown in the center, which increases its safety and prevents a flickering blaze, due to any strong wind which may be blowing. For heating the rivets a plate is placed on top of the furnace which is punched full of holes of a size sufficient to permit the rivet to enter

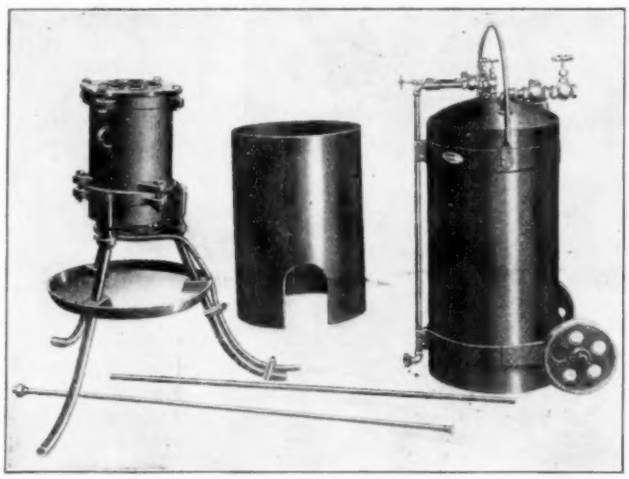


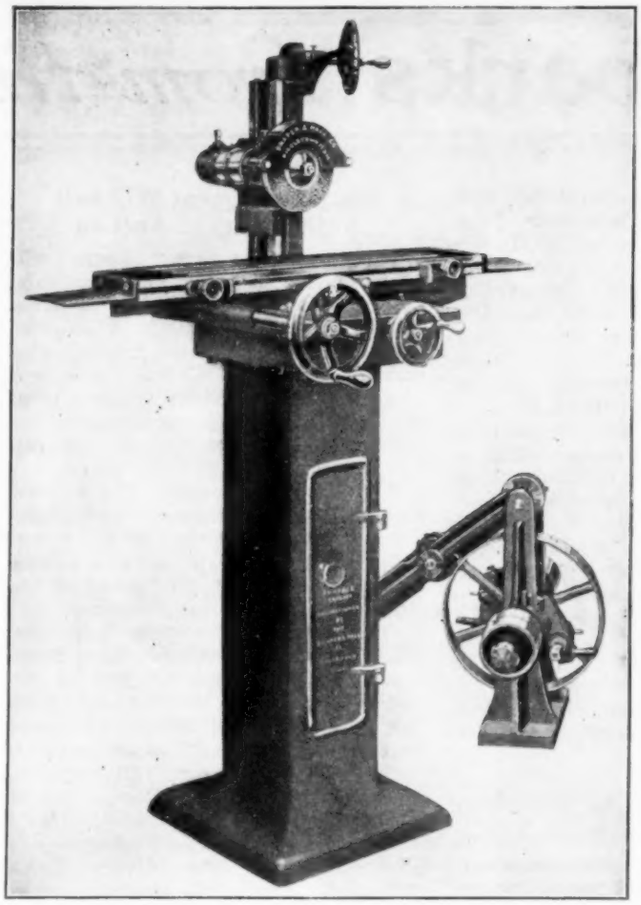
FIG. 2. THE LIBERTY RIVET HEATER

as far as the head, and thus prevent the head from being burned while the rivets themselves are being heated. A tank is used for this furnace similar to that employed with the torch.

Draper & Hall Surface Grinding Machine

The illustration shows the No. 1 surface grinding machine manufactured by the Draper & Hall Co., Middletown, Conn. The sliding table has no overhang, being supported its entire length by the longitudinal slide. The table which is 30 x $6\frac{1}{2}$ in. has a working surface 17 x 6 in. and contains three T-slots $\frac{7}{16}$ in. in width. The lever can be turned down to permit the table to be moved past the stops without changing the dogs.

The hardened and ground spindle runs in tapered phosphor-bronze boxes which can be taken up. The end is tapered to take wheels 6 in. in diameter, $\frac{1}{2}$ in. thick with $1\frac{1}{4}$-in. hole. The feeds are graduated to read



DRAPER & HALL SURFACE GRINDING MACHINE

to one-thousandth of an inch and the sliding surfaces are hand scraped and provided with gibs. The machine is furnished with hand or power feed as desired. The capacities of the various feeds are as follows: Longitudinal, 17 in.; cross, 6 in.; vertical, 8½ in. The weight is 750 pounds.

Convention of Railway Foremen

The nineteenth annual convention of the International Railway General Foremen's Association was held at the Hotel Sherman, Chicago, Ill., Sept. 2, 3, 4 and 5, 1919, and in connection with this convention, the Association of Railway Supply Men held their annual exhibit. The meetings of the General Foremen's Association were held under the direction of President L. A. North, shop superintendent, Illinois Central Railroad, Chicago, and Secretary-Treasurer W. Hall, erecting foreman, Chicago & Northwestern Railway, Winona, Minn.; while the Railway Supply Men met under the direction of President C. C. Schumaker, the Carborundum Co., Chicago, and Secretary-Treasurer H. A. Varney, the Schroeder Headlight and Generator Co., Chicago.

The meetings of the railway foremen were well attended by the enthusiastic gathering, who feel that better times may soon be in sight for the railways, which will enable many of them to make such improvements around their shops as they have been desiring of making for years past; consequently, the discussion of present methods and future plans was of great interest to those actively engaged in this work.

Considerable discussion was aroused on the topic of "Safety First" as this can be applied both in the snops and engine-house service, and many of the general foremen described the methods which have been adopted not only in their own shops but in shops throughout the entire system for attaining a minimum record in the matter of accidents in the shop. Many of the accident-prevention schemes which have been recommended and are being tried out, have involved a system of reward to those shops or portions of railway systems which are most successful in reducing the percentage of accidents.

The welding of locomotive parts and castings, and particularly of locomotive cylinders by both autogenous and electric welding, was also the subject of discussion for a whole morning session. Several papers were presented upon the subject of "Draft Gears."

The annual election of officers of the International Railway General Foremen's Association for the ensuing year resulted as follows: President, W. T. Gale, machine foreman, C. & N. W. Railway, Chicago, Ill.; first vice president, J. B. Wright, general foreman, H. V. Railway, Columbus, Ohio.; second vice president, G. H. Logan, general foreman, C. & N. W. Railway Chicago; third vice president, H. E. Warner, shop superintendent, N. Y. C. Lines, Elkhart, Ind.; fourth vice president, T. J. Mullin, general foreman, L. E. & W. Railway, Lima, Ohio; permanent secretary and treasurer, W. Hall, erecting foreman, C. & N. W. Railway, Winona, Minn. The members of the executive committee are as follows: Chairman, C. H. Barnes, general foreman, Belt Railway, Chicago, Ill.; B. L. Davis; J. Martin; C. F. Bauman; N. B. Whitsel. The location and date of the next convention will be decided later.

The election of officers of the Association of Railway Supply Men for the ensuing year resulted in the following being chosen to head this body: President, Harlow A. Varney, Schroeder Headlight and Generator Co., Chicago; secretary, Clarence L. Mellor, Barco Manufacturing Co., Chicago. The members of the executive committee are B. C. Hooper, St. Paul, Minn.; Bloss P. Corey, Petrola, Ont.; A. W. Cloky, and E. J. Fuller.

A Simple Set of Size Blocks

BY FRED PRICE

On page 231 of the *American Machinist*, A. R. Durant outlines a simple method for making a set of size blocks. On one or two points, for instance, Mr. Durant departs from the best accepted practice in gage making when he hardens the blocks in water and draws them to a light straw color.

Now a size block, to give maximum wear, must be as hard as the arts of man can make it, due allowance being made for the fact that it is drawn very slightly to relieve internal strains. A light straw color, however, is too deep. A better way is to harden the blocks in clean brine and to immediately draw them just enough to sizzle a drop of water.

Mr. Durant also states that lapping the blocks after grinding is not necessary. This is a fallacy because the grinding wheel, no matter how fine or carefully balanced, will not leave a dead true surface. Innumerable high spots are left which soon wear away, leaving the blocks undersize. About 0.0001 in. should be left on each surface for lapping after the grinding operation.

For lapping, carefully washed flour emery, such as opticians use, should be employed. These two suggestions will prolong life of the blocks materially.

Sparks from the

Convention of American Railway Tool Foremen

The annual convention of the American Railway Tool Foremen's Association was held at the Hotel Sherman, Chicago, Ill., Aug. 27, 28 and 29, 1919. In connection with the convention there was also held the annual exhibition of the Supply Association covering this branch of the railway industry. The officers in charge of the convention were: President, C. A. Shaffer, general inspector of tools, Illinois Central R.R., Chicago, Ill.; first vice president, J. C. Beville, tool foreman, El Paso & Southwestern Railway, El Paso, Tex.; secretary and treasurer, R. D. Fletcher, 1145 East Marquette Road, Chicago, Ill.; chairman of the executive committee, B. Henrikson, tool foreman, Chicago & Northwestern R.R., Chicago, Ill.

The meetings were devoted largely to the discussion of a number of papers which were of interest to tool foremen engaged in railway work; and also to the consideration of the reports made by the several standardization committees which were appointed at the last annual convention to recommend such standards as would be advisable for general adoption in the toolrooms of railway shops. The principal work done was in connection with the development of standards for locomotive-frame taper reamers. It was recommended that the standard taper reamers to be carried in stock should have a taper of $\frac{1}{8}$ in. per foot, a shank $1\frac{3}{4}$ in. long and the flutes should be milled with a left-hand spiral. Various lengths and sizes were specified for stock and certain other features were noted in the committees' recommendation.

In connection with the papers to be presented at the ensuing meeting, it was recommended that all committee reports instead of being rendered individually by the different members of the committee, shall be consolidated by the chairman of each committee before being presented to the convention.

The following officers were elected for the ensuing term: President, J. C. Beville, El Paso & Southwestern Ry., El Paso, Tex.; first vice president, J. B. Hasty, Atchison, Topeka & Santa Fé R.R., San Bernardino, Calif.; second vice president, G. W. Smith, Chesapeake & Ohio R.R., Huntington, W. Va.; third vice president, Chas. Helm, Chicago, Milwaukee & St. Paul R.R., Milwaukee, Wis.; chairman executive committee, B. Henrikson, Chicago & Northwestern R.R., Chicago, Ill.

The following committees were appointed to report at the next annual convention: Standardization of Boiler and Staybolt Taps, chairman, E. J. McKernan; Heat-Treatment of Steel in Locomotive Shops, chairman, B. A. Shaffer; Jigs and Devices for Use in Locomotive and Car Repair Shops, chairman, J. J. Sheehan; Standardization of Power-Press Punches and Dies for Locomotive and Car Shops, chairman, Charles Helm; Issuing and Checking of Tools in Locomotive and Car Shops, chairman, J. B. Hasty.

It was decided to hold the next annual convention of the association in Chicago, but the date for this will be selected later by the committee.

At the annual meeting of the Supply Association in connection with this convention, the following officers were elected for the ensuing year: President, C. N. Thulin, Duff Manufacturing Co., Chicago, Ill.; secretary and treasurer, G. W. Thomson, The Norton Co., Chicago, Ill.; executive committee, J. C. Campbell, F. W. Peterson, C. A. Knill, F. A. Lawler, M. F. Crawmer and J. C. Scanlon.

* * *

Norwegian Market for Hardware, Construction Materials, Etc.

"Construction material, hardware, electrical goods, and machinery are very much in demand in Norway," says consul-general Marion Letcher, Christiania, in United States Commerce Reports. "At the first of the year there were practically no stocks on hand, and Norwegian merchants are eager to get in touch with American firms able to make deliveries without too much delay. The two chief ports for the receipt of such goods are Bergen and Christiania, from which centers the goods are distributed to all parts of the country. Unless a firm contemplating the opening of such business with Norway has a branch house here it is advisable to appoint a Norwegian firm to act as agent. Ordinarily, Christiania is the best location for such an agency. The usual terms are 60 to 90 days, and quotations are made preferably c.i.f. Christiania."

* * *

Schuchardt & Schutte Planning to Resume Business

The firm of Schuchardt & Schutte, machine-tool manufacturers of Vienna, are making plans, according to a report from the American vice consul in that city, to resume business operations.

Plans are being developed, it is understood, to establish offices in Belgrade and Agram in an effort to regain their former business.

It is reported that a representative of the company will arrive in this country soon to study the improvements and advances made in the United States during the war in the manufacture of machine tools.

War Department Will Sell Automobiles at Auction

The Motor Transport Corps will offer for sale at public auctions, to be held in the immediate future at army camps and storage yards, a total of 1243 used passenger cars, trucks, automobiles, motorcycles, side cars and bicycles. These vehicles in their present condition are unserviceable for army use, but a number of them can be made usable by proper repairing.

"The War Department has no new or serviceable passenger automobiles for sale at present, and it is not anticipated that it will have any new passenger cars available for sale to the general public," it was announced.

On Sept. 18 the motor transport officer at Camp Holabird, near Baltimore, Md., will begin the sale of 295 unserviceable motor vehicles taken from the total mentioned above. Embraced in this sale will be 56 passenger cars, including Studebakers, Hupmobiles, Overlands, Liberties, Reos, Buicks, Grants, Paiges, Velies, Hudsons, Maxwells, Loziers, Fords, Packards and Chevrolets; five light delivery trucks, principally Fords; 93 two-ton trucks, 99 Nash trucks, 27 three- to five-ton trucks, eight motorcycles and five Excelsior Solo and sidecars. This sale will begin at 9 a.m. on Sept. 18 and will continue until all cars are sold.

On Sept. 19 and Sept. 20 auctions will be held at the Army Supply Base, Norfolk, Va., and Camp Hill and Camp Stewart, near Newport News, Va. The sale at Norfolk will include the Reo, Kissel Kar, Studebaker, Paige and Ford passenger cars; 133 trucks of various sizes and types, among which will be found Pierce-Arrows, Maxwells, Studebakers, Nashes, Reos and Fords, and two motorcycles. The sale at Camp Hill and Camp Stewart will include 25 passenger cars and 74 trucks.

On Sept. 24 the motor transport officer at Philadelphia will offer for sale 18 passenger cars, 98 trucks and three motorcycles.

Inquiries for the dates at which auctions will be held at camps and storage depots and for information concerning the equipment to be offered at each should be addressed to motor transport officers detailed at those points.

* * *

National Machine Tool Builders' Convention

The National Machine Tool Builders' Association will hold its annual convention at the Hotel Astor, New York City, Oct. 15 and 16. Chas. E. Hildreth, Worcester, Mass., is general manager and C. Wood Walter, Cincinnati, Ohio, is secretary.

World's Industrial Forge

By E.C.Porter, News Editor

Convention of the Associated Business Papers, Inc.

The fourteenth annual convention of the Associated Business Papers, Inc., will be held at the Congress Hotel, Chicago, on Sept. 18, 19 and 20. The following is the program for each day:

THURSDAY, SEPT. 18

Address of welcome by the chairman at 9:30 a.m. Response and address by A. C. Pearson, president the Associated Business Papers, Inc. Appointment of credentials and resolutions committees. The following papers will then be read:

"The Partners of Business," H. G. Lord, president of the Textile World Journal, Boston and New York; "How to Make Better Partners of Business," H. M. Swetland, president of the United Publishers Corp., New York; "An Appreciation by Business," Charles Piez, president Link-Belt Co., Chicago; "The Significance of the 'Plumb' Movement in Labor Circles and Its Possible Effect upon Business and Business Papers," Samuel O. Dunn, editor, Railway Age, Chicago.

EDITORIAL SESSION

Introductory remarks at 2 p.m. by the chairman, H. Cole Estep, editorial director, Penton Publishing Co., Cleveland, followed by papers: "How to Help Solve Present-Day Problems," (a symposium of three 35-minute addresses); "Labor," Harry Tipper, manager, Automotive Industries, New York; "Production," Harry Hillman, editor Inland Printer, Chicago; "Merchandising," W. L. Ware, editor, Dry Goods Reporter, Chicago; "How the Editorial Conference Helps Business Papers," David Beecroft, editorial director, Class Journal Co., New York; "How to Have Your Paper Lead as Well as Reflect Opinion," R. J. Patterson, editor, The American Hatter, New York; "How to Get and Train Men for Editorial Work," Ray Sherman, editor, Motor World, New York.

FRIDAY, SEPT. 19

ADVERTISING SESSION

Introductory remarks by the chairman, A. O. Backert, vice president and manager, Penton Publishing Co., Cleveland, at 9.45 a.m. Papers will then follow: "How to Make a Service Department Pay," R. Bigelow Lockwood, manager, service department, McGraw-Hill Publishing Co., New York; "How to Hold Advertising When Demand Exceeds Supply," William T. LeBrecht, assistant treasurer, Boot and Shoe Recorder, Boston; "How to Swat the Waste in Advertising," R. Marshall, president, Concrete, Detroit; "How the Advertising Salesmen Can Prove That His Paper Reaches the Real Buyer," Warren C. Platt, president, National Petroleum News, Cleveland; "The Place of the Business Press in a National Campaign," R. R. Shuman, president, Shuman Advertising Co., Chicago.

CIRCULATION SESSION

This session will be opened by the chairman, F. D. Porter, president, Buildings and Building Management, Chicago, at 2:15 p. m. The papers follow: "How to Reduce Circulation Mortality," L. W. Seeligsberg, vice president, McGraw-Hill Publishing Co., N. Y.; "How the Editorial and Circulation Departments Can Coöperate," M. C. Robbins, president, The Gas Age, New York; "How to Make Users and Boosters out of Subscribers," speaker to be announced

PUBLISHERS AND BUSINESS SESSION

The chairman, A. C. Pearson, president, the Associated Business Papers, Inc., will open the session at 3:45 p.m. The papers are: "The A. B. C.," Stanley Clague, managing director, The A. B. C., Chicago; "How to Meet the High Cost of Publishing," J. M. Muir, vice president, McGraw-Hill Publishing Co., New York; "The Advertising Agency and the Business Press," Robert Tinsman, president, Federal Advertising Agency and chairman of the business press committee of the American Association of Advertising Agencies.

SATURDAY, SEPT. 20

The chairman, A. C. Pearson, president, the Associated Business Papers, Inc., will open this session at 9:30 a.m. The reports will then follow: Report of the committee on credentials; The postal situation, Arthur J. Baldwin, chairman, postal committee; report of the executive secretary; report of the auditing committee, chairman, Edward Caldwell, treasurer, McGraw-Hill Publishing Co., New York; report of the treasurer; the question of standardizing circulation reports under our Standard of Practice No. 7; report of the committee on agency relations, chairman, Harry Tipper, manager, Automotive Industries, N. Y.; report of representatives on the National Advertising Commission; the observance of Postal Regulations Covering Free Copies to Advertisers; report of the resolutions committee; report of the advisory committee, acting as a nominating committee, chairman, H. M. Swetland, president, United Publishers Corporation, New York.

* * *

The Walden-Worcester Company Erects New Building

The Walden-Worcester Co., Inc., Worcester, Mass., manufacturers of wire-handle socket wrenches has awarded a contract for the construction of a new factory building to cost $250,000.

The new building will be situated on Shrewsbury St. and will be four stories in height. It will be of reinforced-concrete construction throughout and its longest dimensions will be 333 ft. and its width 60 feet.

General and private offices of the company as well as the plant hospital and service rooms will be on the top floor. Factory administration offices will be on the second floor. The rest of the building will be used for manufacturing. The remaining one-story factory building for which contract will be let shortly will provide 12,000 sq.ft. and will house the power plant, nickel plating and hardening departments. The company expects to occupy its new building by Jan. 1, and will require 250 employees.

* * *

Japan Upholds U. S. Trade-Mark Rights

The Supreme Court of Japan in a recent decision has given unqualified support to an American trade-mark registered in Japan. The suit was brought in Japan by the Miller Lock Co., of Philadelphia, to restrain the use by Japanese of the trade-mark of a padlock which the Japanese concern appropriated. Distinguished Japanese counsels were employed and the case given unusual analysis and care.

The court upholds every essential of trade-mark rights, as guaranteed under Japan's treaty with the United States. It means the absolute prohibition of Japanese infringement of foreign trade-marks registered in Japan.

Trade Currents from Cleveland Machinery Districts

The most significant development in machinery markets in the northern Ohio territory in the last week is the marked increase in the demand from general manufacturing. Optimism based upon the larger number of inquiries from these sources is consequently on the upgrade. A prominent official of one of the leading screw-machine manufacturing establishments of the country has just returned to Cleveland after a tour of the eastern shoe and textile industries. He reports that shoe manufacturers look for a continuance of present good business for at least three to five years, and their needs in the matter of machinery will be in proportion. The textile industries, both in the East and the Middle West, have a similar favorable outlook.

During the last week or so there has been marked improvement in the demand from the automobile industry in the Middle West, and particularly from Cleveland manufacturers. These interests now are pushing their production of 1920 cars and trucks, after feeling out the market, and in some instances have planned to increase their original production of next year's vehicles. The result, in the opinion of members of the latter industry, will be increased inquiries for machinery. Probably the most promising development in this connection, machinery manufacturers in this district point out, is the activity of the Willys-Overland interests of Toledo. Principally because of the turn of events of late in connection with the labor troubles at Toledo, this firm is expanding in other sections of the country in order that its original plans for mammoth production of lightweight cars will not be hampered. Machinery interests, therefore, are of the opinion that still greater outlet for their product will be the result of the acquisition of the old Fiat plant at Poughkeepsie, N. Y., and the Duesenberg Motors Corporation, at Elizabeth, N. J., by the Overland company. It is the belief that while the Overland company will not abandon its plant in Toledo, the events of the last few months will have an influence in preventing much expansion in that city.

Machinery interests are not so elated over the prospects for huge production in the proposed Overland Elyria plant, as far as more machinery will be required, because of the shortage of labor in the Cleveland manufacturing territory; however, this may be discounted somewhat by reason of the increase in home building in all sections adjacent to Cleveland. It is now recognized that the principal drawback to a good supply

of labor has been the lack of adequate housing facilities. A significant example of this is the plans of the Zenith Tire and Rubber Co. for locating in Cleveland. This firm, backed by English capital, it is said, plans a $1,000,000 plant here.

Representatives of the Michigan Smelting and Refining Co. were in Cleveland this week to look over the situation regarding warehouse facilities. Storage building is sought by this firm, and headquarters will be established in a downtown office building.

Another factor that will have a big effect upon increasing the demand for machinery during the next few months is the steadily advancing cost of the finished product. Wage increases constantly being demanded is the principal factor in influencing prices now. It is conservatively estimated that the average wage increase in machinery production is 5 per cent. a month at present.

Some of the bigger manufacturing projects that have come to light in the last week or so, that will mean additional demands for varied machinery, are those of the Cleveland Tractor Co. and the Vita Manufacturing Co. Both organizations are planning to build large plants, the former two additional shops at a cost of $400,000, and the latter a factory for the production of the Rogers' magneto. The extent of the operations for the immediate future at the Cleveland Tractor Co. may be estimated by the fact that this plant will have 310,000 sq.ft. of shop and manufacturing space under roof, making it the largest of its kind in the Middle West and one of the largest plants in the Cleveland district. The Vita interests will produce a magneto designed by George D. Rogers, who also is president of the company.

* * *

Airplane Makers Unable to Fill Orders

In the last three months more than 500 persons in the United States have either purchased or ordered airplanes, and were the manufacturers able to deliver planes, more than 500 more orders would be booked. Henry Woodhouse, vice president of the Aërial League of America, says that it is unfortunate for the aëronautic movement that the makers cannot fill their orders. He gives it as his belief that more than 2000 machines for pleasure could be sold immediately.

* * *

England Makes Final Payment for Aviation Supplies

The British government has completed its payments to the United States for aviation supplies furnished during the war. Final payments totaled $35,176,123, and the payments were for Liberty motors, airplane spruce, and other supplies as follows: Liberty motors, $13,672,519; airplane spruce, $13,274,550; wood distillates, $2,887,554; nitrocellulose powder $4,690,000, and cotton linters pool, $651,500.

Personals

CHARLES L. TAYLOR, president of the Taylor & Fenn Co., Hartford, Conn., is laid up at home with a broken leg, from a fall at the shore a couple of weeks ago.

R. S. WEINER has been appointed district manager of the Sullivan Machinery Co., at El Paso, Tex., succeeding DON M. SUTOR. Mr. Sutor has been transferred to the company's St. Louis office as district manager.

L. W. CASH, for the past two years purchasing agent of the Wisconsin Parts Co., Oshkosh, Wis., has resigned his position, effective Sept. 1.

Business Items

The Chicago Pneumatic Tool Co. plans moving its general office from Chicago to New York and toward this end is erecting an office building at 6-8 East 44th St., New York City. The new building is to be ready for occupancy in 1920.

The D. Nast Machinery Co., Philadelphia, Penn., has been appointed sales representative of the Cleveland Milling Machine Co., Cleveland Machine Tool Co., Cleveland Planer Co., Cleveland, Ohio, and the Rivett Lathe and Grinder Co., Boston, Mass. The Nast company will carry in its display rooms, the Bourse Building, complete lines of the company's products.

Obituary

OTTO A. RUEMELIN, works manager and second vice president of Pawling & Harnischfeger Co., Milwaukee, Wis., died Sept. 1, 1919. As a youth Mr. Ruemelin began his apprenticeship with the Pawling & Harnischfeger Co. After several years as journeyman he was promoted to the foremanship of various departments. He was later made assistant superintendent, from which position he rose to that of superintendent and finally works manager, which position he has held since 1912. His death concludes a period of 30 years association with Pawling & Harnischfeger Co.

STEPHEN E. FRENCH, 51 years old, past president of the New England Foundrymen's Association, was killed instantly when run down recently by an auto truck in Boston. He was born in Orange, Mass. For many years he was identified with the New Home Sewing Machine Co., Orange, Mass. He learned the toolmaker's trade at the New Home plant and later with other Orange men started the Athol Machine Co., of which he became general manager, remaining in this position until a year ago, when he joined the engineering department of the Worthington Pump and Machinery Corporation, New York. He had more recently been located in Cambridge, Mass. He was a member of the National Metal Trades Association, an honorary member of the American Hardware Manufacturers' Association and was active in the New England Foundrymen's Association.

Catalogs Wanted

The Weber and Scher Manufacturing Co., 24 Scott St., Newark, N. J., which is engaged in the manufacture of dies, jigs, fixtures, gages, special machinery and appliances, has recently organized an engineering department. Catalogs are desired for its files, covering small tool, machine tools, appliances, stock parts, etc.

Forthcoming Meetings

The Association of Iron and Steel Electrical Engineers will hold its convention in St. Louis, Sept. 22-26.

The American Bankers' Association will hold its 45th annual convention in St. Louis, Sept. 29 to Oct. 2.

The American Mining Congress will hold its 22nd annual convention in St. Louis, Nov. 17-21.

American Foundrymen's Association. Annual convention and exhibit will be held in Philadelphia the week of Sept. 29, 1919. C. E. Hoyt, secretary, 111 West Monroe St., Chicago, Ill.

The American Steel Treaters' Society will hold its annual convention and exhibition at the Seventh Regiment Armory, Chicago, Ill., Sept. 22 to 27. Al. J. Murphy, 154 East Erie St., Chicago, Ill., is chairman of the exhibit committee.

Boston Branch, National Metal Trades Association. Monthly meeting on first Wednesday of each month, alternating with the Employers' Association of eastern Massachusetts. George D. Berry, secretary, room 50-51, 166 Devonshire St., Boston, Mass.

Electric Hoist Manufacturers' Association. Monthly meeting at the offices of the Yale & Towne Manufacturing Co., 9 East 40th St., New York City. Secretary W. C. Briggs, Shepard Electric Crane and Hoist Co.

Engineers' Club of Philadelphia. Regular meeting the third Tuesday of the month, with the exception of July and August. Lewis H. Kenney is the chairman of committee on papers.

Engineers Society of western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

The International Trade Conference called by the Chamber of Commerce of the United States will be held in Atlantic City on Sept. 30 to Oct. 6. Homer L. Ferguson is the president of the National Chamber and A. C. Bedford is the chairman of the executive committee of the conference.

The Machinery Sales Association will hold its fifth convention in Cincinnati, Sept. 20 and 21, under the auspices of the Dayton and Cincinnati associates, Seifreat-Woodruff Co.

Philadelphia Foundrymen's Association. Meeting first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn., Howard Evans, secretary, Pier 45, North Philadelphia, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting last Thursday. O. L. Angevine, Jr., secretary, 547 Arnett Boulevard, Rochester, N. Y.

The National Machine Tool Builders' Association wil hold its annual convention at the Hotel Astor, New York City, Oct. 15 and 16. Chas. E. Hildreth, Worcester, Mass., in general manager, and C. Wood Walter, Cincinnati, Ohio, is secretary.

The National Safety Council will hold its eighth annual Safety Congress in Cleveland, Oct. 1 to 4 at Hotel Statler.

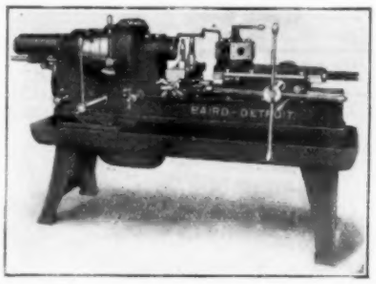
Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Screw Machine, No. 4 Hand

Baird Machine and Manufacturing Co., Detroit, Mich.

"American Machinist," Aug. 28, 1919

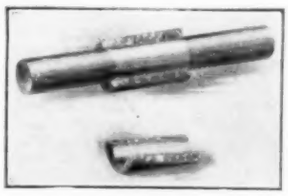


Automatic chuck capacity, 1¼ in. round, 1 1/16 in. square, 1 5/16 in. hexagon; size of hole through plunger, 1 7/16 in.; size of hole through spindle, 1⅞ in.; length that can be turned, 9 in.; swing over bed, 18 in.; swing over cut-off, 8 in.; maximum distance end of spindle to turret face, 21 in.; center of turret hole to top of slide, 3⅜ in.; travel of cut-off (cross), 6½ in.; travel of cut-off (longitudinal), 14½ in.; revolutions of spindle to feed 1 in., 24, 43, 73, 123; capacity of pipe threads (brass), 2 in.; capacity of standard threads (machine steel), 1¼ in.; size of tools in cut-off, ½ in. x 1 in.; floor space required, 28 in. x 82 in.; net weight, 2925 lb.

Bearings, C. G. M. Oilless

The Massachusetts Oilless Bearings Co., Worcester, Mass.

"American Machinist," Aug. 28, 1919

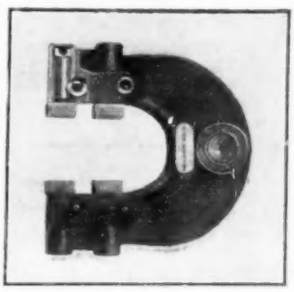


This bearing consists of an intimate mechanical mixture of graphite with any bearing metal alloy which has the requisite physical properties for the job in hand. C. G. M. bearings are designed to run at a temperature of about 100 deg. F., those recommended for high-speed work having a greater proportion of graphite. Four different alloys have been prepared and tested to determine the coefficients of friction and showed respective coefficients of 0.015, 0.012, 0.0094 and 0.0062. These bearings are not made in stock sizes but only to the customer's order.

Gage, Adjustable Limit Snap

American Gage Co., Newark, N. J.

"American Machinist," Aug. 28, 1919

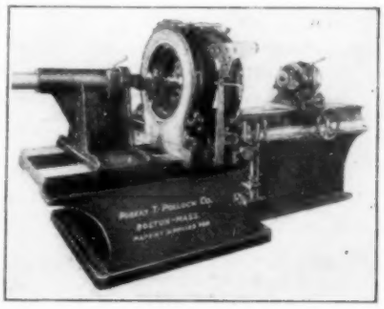


Made in 21 sizes to give all dimensions from 0 to 12 in. Contact surfaces are glass hard and made square to permit getting close to a shoulder. Shanks carrying square-headed contact-pieces are adjusted lengthwise by means of special headless set-screws and are kept from turning by bevel-shouldered headless set-screws set in crosswise so that the bevel shoulder will engage a flat surface running lengthwise of the shank. Lead finger holds provided to prevent the heat of the hand distorting the frame and to afford a good grip.

Milling Machine, Crankpin

Robert T. Pollock Co., Boston, Mass.

"American Machinist," Aug. 28, 1919



After the crankshaft has been clamped in the head and tailstocks and also placed in its proper position in relation to the heads, power is applied to the milling cutters, through the use of one of the levers shown in front. A steadyrest is clamped in position and serves to eliminate vibration in the shafts and the consequent chatter of the milling cut. At the completion of one revolution, the feed is automatically disengaged and the machining of all the crankpins has been accomplished.

Welding Wire, "Raco" Covered

Reid Avery Co., 1436 Brandywine St., Philadelphia, Penn.

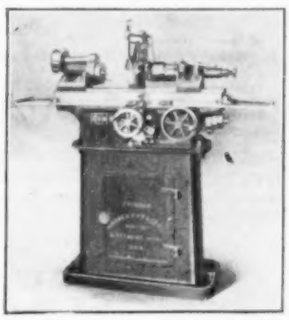
"American Machinist," Aug. 28, 1919

This electrode has been designed especially for electric-arc welding with alternating current, and it is claimed that by its use the weld is generally benefited, inasmuch as the coating or covering of the electrode melts with the metal, covering the weld with a light slag which acts as a flux and prevents oxidation. A steadier arc is also said to be obtained by use of this electrode which can be used with direct as well as alternating current. The rod can be furnished in different sizes to meet various demands.

Grinding Machine, No. 21 Plain

Warren F. Fraser Co., Westboro, Mass.

"American Machinist," Aug. 28, 1919



Specifications: Rated size, 5 x 18 in.; maximum capacity, 6 x 20 in.; swing over water guards, 5 in.; swing over table, 6¾ in.; centers No. 2 Morse taper; head and tailstock spindles, 1¼-in. diameter, hardened and ground; wheel, 12-in. diameter x 1½-in. face x 3-in. hole; wheel drive, 2½-in. belt on 4½-in. pulley; wheel speeds, 1800 and 2150 r.p.m.; work speeds, 30, 50, 75, 107, 150, 210 r.p.m.; table speeds, 7/8 in., 15/16 in., 3/4 in. per revolution of work; countershaft speed, 450 r.p.m.; tight and loose pulleys, 12 in. diameter x 3-in. face; power required, 3 horsepower.

Milling Machine, Crankshaft Main Journal

Robert T. Pollock Co., Boston, Mass.

"American Machinist," Aug. 28, 1919

This is a plain multi-spindle milling machine which simultaneously mills all the main journals concentric with the axis of the shaft. Number of spindles varies with number of journals. Cutters are inexpensive and have a life of 300 to 400 shafts. Limits of 0.00175 in. plus or minus have been maintained.

Dog, Lathe, "Efficiency"

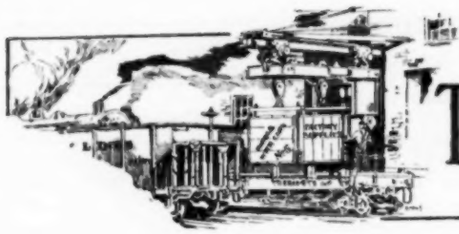
Efficiency Device Corp., 199-203 Eighth St., Long Island City, N.Y.

"American Machinist," Aug. 28, 1919

These dogs do not need a wrench of any kind to operate as they are simply opened, slipped over the work and the cam jaw is closed automatically by springs. These springs are only used to close the jaw and the grip is not dependent on them. The construction of the dog is such that the harder the pull, the tighter is the grip.

These dogs are made of steel drop-forgings, heavily case-hardened and are made in five sizes which will handle anything from ½ to 3 in. in diameter, each dog having an automatic adjustment of ½ in.

Patented Aug. 20, 1918



THE WEEKLY PRICE GUIDE

IRON AND STEEL

PIG IRON—Quotations compiled by The Matthew Addy Co., as per Department of Commerce Committee Schedule.

	Current	One Month Ago
CINCINNATI		
No. 2 Southern	$30.35	$36.90
Northern Basic	27.55	27.55
Southern Ohio No. 2	28.55	28.55
NEW YORK—TIDEWATER DELIVERY		
2X Virginia (Silicon 2.25 to 2.75)	32.40	34.40
Southern No. 2 (Silicon 2.25 to 2.75)	35.20	33.95
BIRMINGHAM		
No. 2 Foundry	29.25	28.00
PHILADELPHIA		
Eastern Pennsylvania No. 2	29-30	30.65
Virginia No. 2	33.10	32.10-34.10
Basic	26.75	29.90
Grey Forge	26.75	29.90
CHICAGO		
No. 2 Foundry local	26.75	26.75
No. 2 Foundry, Southern	28.00	28.00
PITTSBURGH, INCLUDING FREIGHT CHARGE FROM VALLEY		
No. 2 Foundry	28.15	28.15
Basic	27.15	32.00
Bessemer	29.35	35.20

* F. o. b. furnace. † Delivered.

STEEL SHAPES—The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	— New York —			— Cleveland —		— Chicago —	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$3.47	$3.47	$4.245	$3.37	$4.17	$3.47	$4.27
Soft steel bars	3.37	3.37	4.145	3.27	4.07	3.37	4.17
Soft steel bar shapes	3.37	3.37	4.145	3.27	4.17	3.37	4.17
Soft steel bands	4.07	4.07	4.995				
Plates, ¼ to 1 in. thick	3.67	3.67	4.495	3.57	4.42	3.67	4.25

Note—For less than carload lots add 4½c. per 100 lb.

BAR IRON—Prices per 100 lb. at the places named are as follows.

	Current	One Year Ago
Mill, N. Y.	$2.77	$3.50
Warehouse, New York	3.37	4.75
Warehouse, Cleveland	3.27	4.10
Warehouse, Chicago	3.37	4.10

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the base quotations from mill:

	Mill, Carloads Pittsburgh	— New York — Current	— New York — One Year Ago	Cleveland	Chicago
No. 28 black	4.35	5.50	6.495	5.27	5.62
No. 26 black	4.25	5.40	6.395	5.17	5.52
Nos. 22-24 black	4.20	5.35	6.345	5.12	5.47
Nos. 18-20 black	4.15	5.30	6.29	5.07	5.42
No. 16 blue annealed	3.75	4.77	5.695	4.67	4.77
No. 14 blue annealed	3.65	4.67	5.595	4.57	4.67
No. 10 blue annealed	3.55	4.57	5.495	4.47	4.57
No. 28 galvanized	5.70	6.75	7.745	6.62	6.97
No. 26 galvanized	5.40	6.45	7.445	6.32	6.67
No. 24 galvanized	5.25	6.30	7.295	6.17	6.37

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Round shafting or screw stock, per 100 lb. base	$5.00	$4.90	$4.75
Flats, squares and hexagons, per 100 lb. base	5.50	5.40	

DRILL ROD—Discounts from list price are as follows at the places named:

New York	50%
Cleveland	50%
Chicago	50%

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots is:

	Current	One Year Ago
New York	$21.00-26.00	$15.50-19
Cleveland	20.00	20.00
Chicago	16.50	19.00

In coils an advance of 50c. usually is charged.
Domestic iron (Swedish analysis) is selling at 15c. per lb.

WELDING MATERIAL (SWEDISH)—Prices are as follows in cents per pound f.o.b. New York, in 100 lb. lots and over:

Welding Wire		Cast-Iron Welding Rods	
5/32, 3/16, 7/32, 1/4, 9/32, 5/16 No. 8, 3/32 and No. 10	21.00 to 30.00	1/4 by 12 in. long	14.00
No. 12		5/16 by 19 in. long	12.00
1/8, No. 14 and 5/64		3/8 by 19 in. long	10.00
No. 18		1/2 by 21 in. long	10.00
No. 20		Special Welding Wire, Coated	
Domestic 20c. for 5/64, 15c. for 1/4 to 3/8.		1/4	33.00
		5/16	30.00
		3/8	38.00

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York Current	Cleveland Current	Chicago Current
Openhearth spring steel (heavy)	6.50	8.00	8.00
Spring steel (light)	10.00	11.25	11.00
Coppered bessemer rods	8.00	8.00	6.75
Hoop steel	4.07	4.75	4.07
Cold-rolled strip steel	8.40	8.25	7.50
Floor plates	5.67	6.00	5.92

Note—For less than carload lots add 4½c. per 100 lb.

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh: basing card of National Tube Co. for steel pipe, Cardry A. M. Byer's Co. for iron, both dated Mar. 21, 1919.

BUTT WELD

Inches	Steel Black	Steel Galvanized	Inches	Iron Black	Iron Galvanized
1/8, 1/4 and 3/8	50½%	24%	1/8 to 1¼	39½%	23½%
1/2	54½%	40%			
3/4 to 3	57½%	44%			

LAP WELD

2	50½%	35%	2	32½%	18½%
2½ to 6	53½%	41%	2½ to 6	34½%	21½%

BUTT WELD, EXTRA STRONG PLAIN ENDS

1/8, 1/4 and 3/8	46½%	29%	1/2 to 1¼	39½%	24½%
1/2	51½%	39%			
3/4 to 1¼	55½%	43%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	48½%	37%	2	33½%	20½%
2½ to 4	51½%	40%	2½ to 4	35½%	23½%
4½ to 6	50½%	39%	4½ to 6	34½%	22½%

Stock discounts in cities named are as follows:

	— New York — Black	— New York — Galvanized	— Cleveland — Black	— Cleveland — Galvanized	— Chicago — Black	— Chicago — Galvanized
⅛ to 3 in. steel butt welded	47%	31%	43½%	34½%	57½%	44%
2½ to 6 in. steel lap welded	42%	27%	45½%	30½%	53½%	41%

Malleable fittings, Class B and C, banded, from New York stock sell at plus 12½% less 5%. Cast iron, standard sizes, 10-5% off.

METALS

MISCELLANEOUS METALS—Present and past New York quotations in cents per pound, in carload lots:

	Current	One Month Ago	One Year Ago
Copper, electrolytic	22.50	24.00	26.00
Tin in 5-ton lots	56.50	60.00	83.00
Lead	5.90	5.90	8.05
Spelter	7.70	7.95	9.50
ST. LOUIS			
Lead	5.75	5.50	7.75
Spelter	7.35	7.60	9.25

At the places named, the following prices in cents per pound prevail, for 1 ton or more:

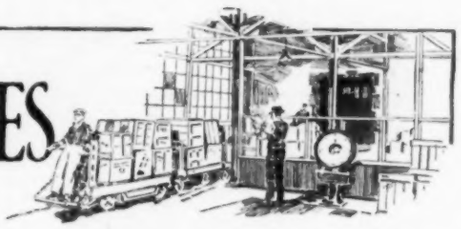
	— New York — Current	— New York — One Month Ago	— New York — One Year Ago	— Cleveland — Current	— Cleveland — One Year Ago	— Chicago — Current	— Chicago — One Year Ago
Copper sheets, base	33.50	33.50	38.00	35.50	38.00	36.50	33.50
Copper wire (carload lots)	29-30.75	28.25	35.00	30.50	35.00	26.00	33.00
Brass sheets	32.00	27.75	39.75	33.00	37.00	28.00	31.50
Brass pipe	36.00	36.00	46.00	39.00	42.00	37.00	41.50
Solder (half and half) (case lots)	45.00	45.00	58.00	41.00	57.50	38.50	56.00

Copper sheets quoted above hot rolled 16 oz., cold rolled 14 oz. and heavier, add 1c.; polished takes 1c. per sq.ft. extra for 20-in. widths and under; over 20 in., 2c.

BRASS RODS—The following quotations are for large lots, mill. 100 lb. and over, warehouse; net extras:

	Current	One Year Ago
Mill	$24.00	$32.25
New York	28-29.75	34.25
Cleveland	29.00	36.60
Chicago	27.00	29.50

SHOP MATERIALS AND SUPPLIES



ZINC SHEETS—The following prices in cents per pound prevail:

Carload lots f. o. b. mill 11.00

	In Casks		Broken Lots	
	Current	One Year Ago	Current	One Year Ago
Cleveland	12.50	18.75	13.00	18.40
New York	11.50	16.50	12.50	17.00
Chicago	16.50	22.00	16.00	21.50

ANTIMONY—Chinese and Japanese brands in cents per pound, in ton lots for spot delivery, duty paid:

	Current	One Year Ago
New York	9.50	14.00
Chicago	9.75	15.00
Cleveland	12.00	17.125

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York		Cleveland		
	Current	One Year Ago	Current	One Year Ago	Chicago
Copper, heavy and crucible	17.00	24.00	18.00	24.75	19.00
Copper, heavy and wire	16.00	22.50	19.00	24.00	18.50
Copper, light and bottoms	14.00	20.50	17.00	22.00	17.50
Lead, heavy	4.75	7.00	5.00	8.00	5.25
Lead, tea	3.75	5.25	3.50	6.00	4.375
Brass, heavy	10.50	14.75	14.00	17.00	18.50
Brass, light	7.50	11.00	10.50	13.00	11.50
No. 1 yellow brass turnings	10.00	13.75	11.50	16.00	11.00
Zinc	5.00	6.50	5.00	6.00	6.00

ALUMINUM—The following prices are from warehouse at places named:

	New York	Cleveland	Chicago
No. 1 aluminum, 98 to 99% pure, in ingots for remelting (1-15 ton lots), per lb.	35c.–37c	32.00c.@33.00c.	33½c.

COPPER BARS from warehouse sell as follows in cents per pound, for ton lots and over:

	Current	One Year Ago
New York	32.00	32.00
Chicago	31.00	38.00
Cleveland	35.00	36.50

BABBITT METAL—Warehouse price per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	90.00	110.00	70.00	98.00	60.00	96.00
Commercial	50.00	50.00	16.50	23.00	13.00	25.00

SHOP SUPPLIES

New York prices will be revised in next week's issue.

NUTS—From warehouse at the places named, on fair-sized orders, the following amount is deducted from list:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Hot pressed square	$1.50	+$2.50	$2.25	$1.20	$1.85	$1.05
Hot pressed hexagon	1.50	+2.50	2.25	1.00	1.85	.85
Cold punched hexagon	1.50	+2.50	2.25	.75	1.30	1.00
Cold punched square	1.50	+2.50	2.25	.75	1.30	1.00

Semi-finished nuts sell at the following discounts from list price:

	Current	One Year Ago
New York	50-10%	50%
Chicago	50%	50%
Cleveland	60-10%	50%

MACHINE BOLTS—Warehouse discounts in the following cities:

	New York	Cleveland	Chicago
½ by 4 in. and smaller	50%	50%	50–5%
Larger and longer up to 1¼ in. by 30 in.	40%	40%	40–5%

WASHERS—From warehouses at the places named the following amount is deducted from list price:

For wrought-iron washers:

New York.....$1.25 Cleveland.....$3.75 Chicago.....$3.00

For cast-iron washers the base price per 100 lb. is as follows:

New York.....$6.00 Cleveland.....$3.75 Chicago.....$4.25

CARRIAGE BOLTS—From warehouses at the places named the following discounts from list are in effect:

	New York	Cleveland	Chicago
½ by 6 in. and smaller	45–5%	40–5%	50–5%
Larger and longer up to 1 in. by 30 in.	35%	37½%	30–10%

COPPER RIVETS AND BURS sell at the following rate from warehouse:

	Rivets		Burs	
	Current	One Year Ago	Current	One Year Ago
Cleveland	20%	List plus 10%	10%	List plus 10%
Chicago	20%	List price	20%	List plus 20%
New York	40%	20% from list	20%	List plus 20%

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ½ and smaller	50–10%	55% off	55%
Tinned	50–10%	55% off	55%

Boiler, ½, ¾, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York...$5.25 Cleveland...$4.00 Chicago....$4.87 Pittsburgh...$4.65

Structural, same sizes:

New York...$5.35 Cleveland...$4.10 Chicago....$4.97 Pittsburgh...$4.75

MISCELLANEOUS

SEAMLESS DRAWN TUBING—The base price in cents per pound from warehouse in 100-lb. lots is as follows:

	New York	Cleveland	Chicago
Copper	37.50	41.50	38.50
Brass	36.00	39.00	37.00

For immediate stock shipment 3c. is usually added. The prices, of course, vary with the quantity purchased. For lots of less than 100 lb., but not less than 75 lb., the advance is 2c.; for lots of less than 75 lb., but not less than 50 lb., the advance is 5c. over base (100-lb. lots); for less than 50 lb., but not less than 25 lb., 10c. should be added to the base price; and for quantities of from 10 to 25 lb. the extra is 25c.; less than 10 lb., add 35c.

Double above extras will be charged for angles, channels and sheet-metal mouldings if ordered in above quantities. The above extras also apply to brass rod other than standard stock sizes—stock sizes being considered as ¼ up to 2 in. inclusive in rounds, and ¼ up to 1½ in., inclusive in square and hexagon—all varying by thirty-seconds up to 1 in. and by sixteenths over 1 in. On all shipments aggregating less than 100 lb. there is usually a boxing charge of $1.50.

LONG TERNE PLATE—For No. 28 primes, from Stock, the price in Chicago is $7.75 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	13.00	11.00–13.00	14.00	11.00 to 14.00
Colored mixed	9.00 to 12.00	8.50–12.00	11.00	9.50 to 12.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½ x 13½	13½ x 20½
Cleveland	52.00	58.00
Chicago	41.00	43.50

SAL SODA sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$1.75	$1.75	$1.75
Philadelphia	1.75	1.75	1.75
Cleveland	2.75	2.75	2.40
Chicago	2.00	2.00	2.00

ROLL SULPHUR in 360-lb. bbl. sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$3.65	$3.65	$4.30
Cleveland	3.875	3.62	4.60
Chicago	4.12½	4.125	4.00

COKE—The following are prices per net ton at ovens, Connellsville, and cover the past five weeks:

	Sept. 11	Sept. 4	Aug. 27	Aug. 21	Aug. 14
Prompt furnace	$4.75	$4.75	$4.00	$3.90	$3.90
Prompt foundry	5.50	5.50-6.25	5.50	5.50	5.25

FIRE CLAY—The following prices prevail:

		Current
Ottawa, bulk in carloads	per ton	$8.00
Cleveland	375-lb. bag	2.50

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Raw in barrels (5 bbl. lots)	$2.15	$1.90	$2.50	$2.10	$2.37	$2.05
5-gal. cans	2.30	2.00	2.75	2.25	2.57	2.25

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current Dry and In Oil	1 Year Ago Dry and In Oil
	Dry	In Oil	Dry	In Oil		
100-lb. keg	13.00	14.50	14.00	14.50	13.00	14.00
25 and 50-lb. kegs	13.25	14.75	14.25	14.75	13.25	14.25
12½-lb. keg	13.50	15.00	14.50	15.00	13.50	14.50
5-lb. cans	15.00	16.50	.....	.....	15.00	16.00
1-lb. cans	16.00	17.50	.....	.....	16.00	17.00

500 lb. lots less 10% discount; 2000 lb. lots less 10-2½% discount.

NEW AND ENLARGED SHOPS

Consult the Buying Section when in need of machinery or supplies

Metal Working

NEW ENGLAND STATES

Conn., Bridgeport—D. J. Byrnes, 845 Connecticut Ave., has had plans prepared by Maloney & Krokstedt, Archs., 925 Main St., for a 1 story, 50 x 110 ft. garage, to be erected on Stratford Ave. Estimated cost, $25,000.

Conn., Danbury—Doran Bros., River St., manufacturer of hatter's machinery, has awarded the contract for a 1 story, 90 x 200 ft. machine shop, to be erected on South St. Estimated cost, $55,000.

Conn., Waterbury—The Manufacturers' Foundry Co., Railroad Hill, has had plans prepared by F. A. Webster, Arch., 51 West Main St., for the erection of a 2 story, 50 x 120 ft. foundry, a 1 story, 50 x 50 ft. shop, and a 1 story, 100 x 100 ft. storage plant. Estimated cost, $60,000.

Mass., Lowell—The Standard Oil Co., 26 Broadway, New York City, has awarded the contract for the erection of a 1 story garage and a 1 story warehouse, to be erected on Main and Canada St., here. Estimated cost, $100,000. Noted Feb. 13.

Mass., Millbury—J. F. Frazier plans to build a 2 story, 64 x 78 ft. garage, on South Main St. Estimated cost, $25,000. J. P. Kingston & Son, 518 Main St., Arch.

Mass., Northampton—C. A. Maynard, Green St., manufacturer of hoes and shovels, plans to rebuild his forge shop, which was recently destroyed by fire. Estimated cost, $20,000.

Mass., Springfield—The Winchester Square Realty Co., Winchester Sq., has awarded the contract for a 1 story, 54 x 143 ft. garage, with a 42 x 121 ft. ell, to be erected on Mason St. Estimated cost, $35,000. Noted Sept. 11.

Mass., Worcester—B. L. Handelman, Portland St., will build a 2 story, 150 x 200 ft. garage, on Mechanic St. Estimated cost, $100,000. C. R. Hoyle, 390 Main St., Arch. Noted July 31.

Mass., Worcester — Walden-Worcester, Inc., 71 Commercial St., has awarded the contract for a 4 story, 60 x 333 ft. factory, to be erected on Shrewsbury St., for the manufacture of wrenches. Estimated cost, $250,000. Noted July 3.

R. I., Providence—C. B. Bullock, 9 Seekonk St., will build a 1 story, 21 x 120 ft., and 21 x 79 ft. garage. Estimated cost, $30,000. Page & Page, 87 Weybosset St., Arch. Noted Aug. 14.

R. I., Providence—The Fulford Manufacturing Co., Summer and Conduit St., manufacturer of metal ornaments, is having plans prepared by W. R. Walker & Son, Arch., 17 Custom House St., for the erection of a 2 story, 154 x 210 ft. garage and factory. Estimated cost, $60,000. Noted May 8.

R. I., Providence—P. J. Naugle, Wood St., plans to build a 1 story, 116 ft. in diameter, circular garage, on Sprague, Fuller and Westfield St. Estimated cost, $25,000. W. G. Richards, 17 Exchange St., Arch.

R. I., Providence—Silverman Bros., 150 Chestnut St., manufacturer of jewelry, will build a 1 story, 100 x 150 ft. garage, on Lexington Ave. Estimated cost, $50,000.

MIDDLE ATLANTIC STATES

Md., Baltimore—The Reinhardt Motor Car Co., 128 West North Ave., has awarded the contract for a 3 story, 40 x 160 ft. sales and service station, to be erected on Oak St. and North Ave. Estimated cost, $60,000. Noted July 31.

Md., Baltimore—The Thermopak Co., Omaha, Neb., plans to build a plant, here, for the manufacture of iceless and saltless ice cream refrigerators. Estimated cost, $150,000. Address W. R. Lenderking, c/o the Purity Paper Vessels Co., 5-11 West Conway St.

N. J., Camden—The W. Webster Co., 21 South 12th St., Philadelphia, Penn., has awarded the contract for a 2 story, 56 x 123 ft. factory, to be erected here, for the manufacture of heaters.

N. J., Newark—The Atlantic Smelting and Refining Co., Ave. R, has awarded the contract for the erection of a 1 story refining plant. Estimated cost, $100,000.

N. J., Newark—The Prest-O-Lite Co., 786 Frelinghuysen Ave., manufacturer of storage batteries for automobiles, oxy-acetylene welding apparatus, etc., has awarded the contract for the erection of a group of factory buildings, to consist of 8 buildings from 30 x 40 ft. to 60 x 400 ft. in size.

N. Y., New York (Borough of Bronx)—The C. & P. Realty Co., 2167 Belmont Ave. will build a 1 story, 102 x 136 ft. garage, on Southern Boulevard and Freeman St. Estimated cost, $35,000.

N. Y., New York (Borough of Bronx)—S. Katz, 1411 Grand Concourse, will build a 2 story, 75 x 100 ft. garage on 47th St. and 1st Ave. Estimated cost, $35,000. Noted Sept. 11.

N. Y., New York (Borough of Bronx)—E. Maixman, 309 East 142nd St., will build a 1 story, 75 x 99 ft. garage on 142nd St. and Bradhurst Ave. Estimated cost, $20,000.

N. Y., New York (Borough of Brooklyn)—H. Fein, 626 Essex St., will build a 1 story, 75 x 175 ft. garage, on Hilside and Jamaica Ave. Estimated cost, $35,000.

Penn., Philadelphia—The Hale & Kilburn Corporation, 18th and Lehigh St., manufacturer of automobile bodies, has awarded the contract for a 5 story, 196 x 260 ft. factory, to be erected on 16th and Glenwood St. Estimated cost, $100,000.

Penn., Philadelphia—The Kolb Bakery Co., 56th and Market St. has awarded the contract for a 1 story, 48 x 69 ft. and a 1 story, 64 x 65 ft. garages, to be erected at 1009-13 Melon St. Estimated cost, $11,000 and $12,000, respectively.

Penn., Philadelphia—J. Scott & Co., American and Diamond St., has awarded the contract for the erection of an 8 story 50 x 57 ft. garage. Estimated cost, $10,000.

Penn., Philadelphia—J. Witkowski, Allegheny and Salmon St., has awarded the contract for a 1 story, 70 x 150 ft. garage, to be erected on Richmond and Wensley St. Estimated cost, $20,000.

SOUTHERN STATES

W. Va., Huntington—The West Virginia Rail Co., 18th St. and 2nd Ave., plans to build a 1 story factory. Estimated cost, $20,000.

MIDDLE WEST

Ill., Chicago—The Allbright-Nell Co., 5323 South Western Ave., manufacturer of packing house machinery, has awarded the contract for a 1 story, 140 x 200 ft. factory, to be erected at 5319 South Western Ave. Estimated cost, $75,000.

Ill., Chicago—P. L. Brady, c/o O. Runde, Arch., 4831 Barry Ave., has awarded the contract for a 1 story, 70 x 100 ft. garage, to be erected at 409 West Superior St. Estimated cost, $15,000.

Ill., Chicago—Rackey & Son, 2710 Wentworth Ave., have had revised plans prepared by A. M. Ruttenberg, Arch., 4706 North Winchester Ave., for a 1 story, 100 x 125 ft. garage, to be erected at 2714 Wentworth Ave. Estimated cost, $12,500. Noted July 24.

Ind., Valparaiso—The McGill Manufacturing Co., manufacturer of electrical supplies, will build a 3 story, 65 x 260 ft. factory. Estimated cost, $150,000. T. L. Condran Co., 53 West Jackson St., Chicago, Ill., Engr.

Mich., Bay City—The Board of Education is having plans prepared by Pratt, Bickel & Campbell, Arch., 514 Crapo Blk. and Perkins, Fellows & Campbell, Arch., 814 Tower St., Chicago, Ill., for a 3 story high school, including manual training shops, to be erected on Columbus Ave. Estimated cost, $1,000,000.

Mich., Bay City—The C. R. Wilson Body Co., 26th and Farragut St., is having revised plans prepared by A. E. Munger, Arch., 420 Shearer Blk., for the erection of a 1 story, 100 x 316 ft. factory, for the manufacture of automobile bodies.

Mich., Detroit—The Detroit Twist Drill Co., Fort St. and 14th Ave., will build a 3 story, 45 x 87 ft. factory. Smith, Hinchman & Grylls, 710 Washington Arcade, Arch.

Mich., Detroit—The Garfield Cartage Co., Harper Ave., is having plans prepared by A. G. Shutt, Engr., 1333 Book Bldg., for the erection of a 1 story, 30 x 70 ft. garage.

Mich., Detroit—The Michigan Machine Co., 16th and Porter St., manufacturer of cash registers, is having plans prepared by Brown & Preston, Arch., 406-8 Empire Bldg., for the erection of a 3 story, 107 x 158 ft. factory. Estimated cost, $150,000.

Mich., Detroit—The Monarch Foundry Co., Greenwood Ave. and Grand Trunk Ry., is having plans prepared by the H. M. Lane Co., Engr., Owen Bldg., for a 1 story, 100 x 200 ft. grey iron foundry, to be erected on Herrick St. and Vernor Ave.

Mich., Jackson—The Michigan Seating Co., East Washington St., will build a 5 story, 133 x 265 ft. factory, for the manufacture of automobile accessories. H. L. Mead, Grand Rapids, Arch.

Ohio, Cleveland—The Automobile Equipment Co., Blackstone Bldg., has awarded the contract for a 2 story, 65 x 100 ft. factory to be erected on Prospect Ave. Estimated cost, $60,000. Noted Sept. 4.

Ohio, Cleveland—The Colburn Machine Tool Co., 1041 Ivanhoe Rd., has awarded the contract for a 1 story, 192 x 238 ft. factory, to be erected at 1040 Ivanhoe Rd. Estimated cost, $100,000. Noted Sept. 4.

Ohio, Cleveland—The Enamel Products Co., 341 Eddy Rd., has awarded the contract for a 2 story, 40 x 180 ft. addition to its factory. Estimated cost, $10,000. Noted Aug. 28.

Ohio, Cleveland—The Ferry Cap and Screw Co., 2151 Scranton Rd., has awarded the contract for a 1 story, 39 x 48 ft. addition to its factory. Estimated cost, $7000.

Ohio, Cleveland—The Fulton Foundry and Machine Co., 1209 Marquette Rd., has awarded the contract for a 1 story, 100 x 111 ft. addition to its factory on East 75th St. and Morgan Rd. Estimated cost, $70,000. Noted Nov. 21.

Ohio, Cleveland—The General Bronze and Foundry Co., 4900 Hamilton Ave., plans to build a 1 story, 100 x 125 ft. factory, on East 49th St. Estimated cost, $60,000.